POWER

A McGRAW-HILL PUBLICATION—ESTABLISHED 1884
ELY C. HUTCHINSON, *Editor*

Volume 72 NEW YORK, JULY 8, 1930 *Number 2*

To Him Who Loves His Job

I sing to the man who's in love with his job—
Who's found what he's fitted to do,
And knows that he fits it,
And freely admits it—
And's almighty proud of it, too!
He knows that he's master of all of its cares;
They bring him no worry, nor fret.
And tho they may try him
They'll never defy him—
He knows that he'll conquer them yet!

So why should he worry because he is blocked,
When something has baffled his wits?
It only inspires him,
And fightingly fires him
To conquer the thing ere he quits!
He isn't a fellow who's watching the clock,
And waiting the end of the day—
The hours are too meager.
And he's just as eager
To work—as are loafers, to play!

He may work with his head, or may work with his hands,
He may be a salesman, or clerk—
A fireman, or preacher,
A doctor, a teacher.
It isn't the class of the work,
That makes him to love it—nor is it the pay
He gets for his hands, or his wits.
It lies in his knowing
That he is bestowing
His *best* to a job that he *fits!*

—CHARLES S. KINNISON

EDITORIALS

Life of Equipment at High Temperatures

UNDER present-day steam conditions the life of power plant equipment, as used for accounting purposes, is at best merely an intelligent guess. The designer builds for long life, but equipment generally becomes obsolete before it is worn out.

High steam temperatures, toward which there is a discernible trend, will bring with them the problem of deciding the life of high-temperature equipment at the time it is designed. This new design problem is caused by the creep characteristics of metals at elevated temperatures.

Some authorities propose that, where mechanical clearance is not a factor, a total creep of five per cent during the useful life of the equipment would not be objectionable, and that design stress should be limited so as not to cause this value to be exceeded. Thus the useful life of equipment must be decided before work can commence.

Twenty-five years is considered a reasonable useful period for modern power plants. Whether such long life will be economical for the high-temperature parts of the power house is questionable. Some discussion of this point will be welcomed by those contemplating designs for high-temperature conditions.

Business Starts Upward

IN RECOGNITION of a situation every intelligent participant in American industry should understand, *Power* prints this week, in the news section, a business forecast of unusual interest.

Public opinion—even supposedly well-informed business opinion—trails behind the facts. It is notoriously unable to detect trends.

Storm signs were out long before the Wall Street crash last Fall, but the public and most business men remained under the sway of a mass optimism that knew no bounds and laughed at all warnings.

Today the situation is exactly reversed. In the opinion of the best-qualified economists, the business recession has reached bottom. A definite recovery, slow for several weeks and then pronounced, seems certain from a study of the indices whose movements have always preceded those of business by several months.

Running true to historical form, it is just now when solid reasons for optimism are greatest that the "blue funk brigades of business are enjoying their June walks in the cemetery," to use an expression of the *Business Week*.

Clearly, this is the time for level-headed business men to mend their fences without delay and get ready for a recovery which may catch many unprepared.

Sales managers will find it none too early for the laying out of campaigns that will keep ahead of the growing demand by a safe competitive margin. Engineers, too, have a job—that of getting their plants in shape for efficient operation in a period of growing production.

Administering the Federal Water Power Act

IN HIS message to Congress last year President Hoover recommended that he be given authority to appoint a full-time Federal Power Commission. This suggestion was made a reality when the President signed the recent Parker bill to reorganize the commission. Under the Federal Water Power Act, passed by Congress in 1920, the commission consisted of the Secretaries of War, Agriculture, and Interior. The heads of these departments have large responsibilities and do not have the required time to devote to the administration of the water-power act. Furthermore, many conflicting interests in water-power projects and other responsibilities have developed that did not exist or were not apparent when the commission was first created. The indications are that these responsibilities will increase in the future. If the Federal Water Power Act is to serve the purpose for which it was intended, its administration must be the task of those who can devote full time to the work.

Many of the objections to the way the water-power act has been administered were not the fault of the commission. One of the greatest difficulties has been the lack of sufficient funds and personnel to execute the work. In this respect the commission's activities have been so hampered as to retard water-power development. Unless Congress gives the full-time commission proper support many of the old evils will not be corrected. There is a tremendous amount of work connected with the commission's office that must be done before licenses can be granted for new developments. To take care of this requires something more than efficient administration, although the latter is very important.

Water power is one of the nation's most valuable natural resources, and the only one remaining in public control. The Federal Government has assumed the responsibility of protecting the public's interests therein. This it should do by providing for the efficient administration of the Federal Water Power Act.

High-Voltage Alternating Current in Buildings

DIRECT CURRENT has been preferred for building power distribution. Increased size of buildings has created conditions where direct-current distribution is expensive. Large feeders are required to maintain good voltage regulation. This problem is further aggravated by the long feeder, required to reach the top floors of some buildings.

The development of variable-voltage control for high-speed elevators eliminated one of the chief reasons for supplying direct current to buildings. With this type of control a motor-generator set is required to supply power for each elevator motor. These sets, where alternating current is used, serve the dual purpose of providing direct current and operating as part of the elevator control. The ventilating fans represent another load where adjustable speed is required. In this application the speed range is such that it can easily be obtained with wound-rotor induction motors. This method is not as efficient as the use of direct-current motors with field control, but the characteristics of the load are such that the power losses in a wound-rotor motor are comparatively small at reduced speed.

These conditions have made it desirable to use alternating current in large buildings. The power can be transmitted at high voltage to transformer banks on different floor levels and from there distributed at low voltage. Cost of distribution is materially reduced, and practically one hundred per cent reliability can be obtained. The reduced length of the low-voltage feeders insures better voltage regulation than can be obtained with direct current.

As in all alternating-current systems the power-factor problem must be considered. In buildings with variable-voltage elevator control the power factor will be low, because the motor-generators operate a large part of the time lightly loaded. This is no longer a serious problem, as static condensers may be used to correct the power factor. These are comparatively low in cost, simple to operate, and have high efficiency. Synchronous motors used to drive air and refrigerating compressors will serve the dual purpose of power drive and power-factor correction.

High-voltage alternating current for power distribution in large buildings is comparatively new, but sufficient experience has been gained to show that the engineering problems have been solved and that its use is both practical and economically sound.

A Coat of Paint

THE DESIRABILITY of providing clean and light boiler and engine rooms has been urged so often in these columns that it seems a repetition to discuss the subject again. Yet recent visits to many small power plants have demonstrated that many executives do not realize the value of good lighting and good housekeeping.

Dingy, dirty, greasy engine rooms, coupled with dark, dusty, and ill-kept boiler rooms, lead to wasteful and careless methods of operation. The workers in such plants adopt a "What's the use?" attitude and have a discouraged outlook on their jobs. One cannot expect them to do their best under such conditions.

Let the owner spend a few dollars in thoroughly cleaning up both engine and boiler rooms and then give each a coat of white aluminum paint throughout. The change will be marvelous. The men will feel that it is up to them to keep the plant clean and neat. The improved surroundings will inspire a desire to secure better operation, so that the savings will in a remarkably short time pay the cost of the clean-up and painting. One has to experience such a change to realize its real potentialities.

Perhaps this may inspire some power house owner to increase his profits by spending some money in a coat of paint for his power plant.

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POWER *Stands for . .*

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**
8. **Prevention of Smoke, Within Reason**

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SERVICING the World's Largest Building

Chicago Architectural Photographing Co.

Chicago's Merchandise Mart purchases current for power and lighting. Steam is generated for direct and indirect heating

A CITY with a permanent population of 30,000 under a single roof is one way of describing the magnitude of the new Merchandise Mart of Chicago, recently opened for occupancy by Marshall Field and Company. Facilities to accommodate twice that many transients are available to serve the thousands of buyers and sales people who will come and go within its doors during the course of a day.

Occupying the air rights over the Chicago & Northwestern Railway between Wells and Orleans Streets, the new building faces a 100-ft. boulevard bordering the north bank of the Chicago River and commands an unobstructed view of Wacker Drive and the entire Loop district. The main structure is eighteen stories high, and the central tower over the main entrance rises twenty-four stories. The total floor space is 4,000,000 sq.ft., equal to approximately 91.8 acres.

To give some idea of the services required, the distribution of the space will be of interest. On the main floor the lobby contains the buyers' service departments, a bank, restaurant, branch post office, drug store, and numerous convenience stands and shops. Grouped on the second floor are exhibition halls for temporary exhibits, fashion shows, and special displays held by the regular tenants of the mart. Merchandise displays, sales quarters, and offices use all floors from the third to the eighteenth, inclusive. Four of these floors are occupied by Marshall Field & Company. The main dining room and roof garden occupy the nineteenth floor at the foot of the central tower. A merchants' club with comprehensive facilities for the accommodation of visiting retailers uses the four floors from the twentieth to the twenty-third, and on the topmost floor of the tower is a convention hall. On the roof a two-story addition, 200x200 ft., will be occupied by the studios of the National Broadcasting Company.

Services of the usual order are supplied to the building by simple, standard equipment. Steam is generated for direct heating, indirect fan units, hot water, and the pumps. Alternating current in bulk is purchased for lighting and power at a rate that prohibited a

substantial investment in generating equipment from which much of the exhaust steam would be wasted to atmosphere for at least six months of the year. Twenty-nine elevators serve the building. Over 100 fresh-air and exhaust fans, motor-driven through V-belts, ventilate much of the space. There is refrigeration for the kitchen and restaurant on the first floor, for the air-conditioning system in the broadcasting quarters, and for the freight transfer space of the Chicago & Northwestern Railway. The compressors supplying this service are motor-driven, as are the elevators, all of the fans, and some of the pumps, so that the total connected power load mounts to 7,000 hp. The connected lighting load approximates 8,000 kilowatts.

To heat the building over 208,000 sq.ft. of direct radiation is served by a two-pipe vacuum downfeed system. High-pressure steam is carried to the top of the building and reduced to the required pressure, ranging from atmospheric to 5 lb., for distribution to the radiators. The returns are collected at the bottom by three steam-driven vacuum pumps, each having capacity to handle one-half the entire load (which consists of condensate from direct and indirect heating and domestic water heaters) while maintaining a vacuum of 10 in. throughout the entire return piping.

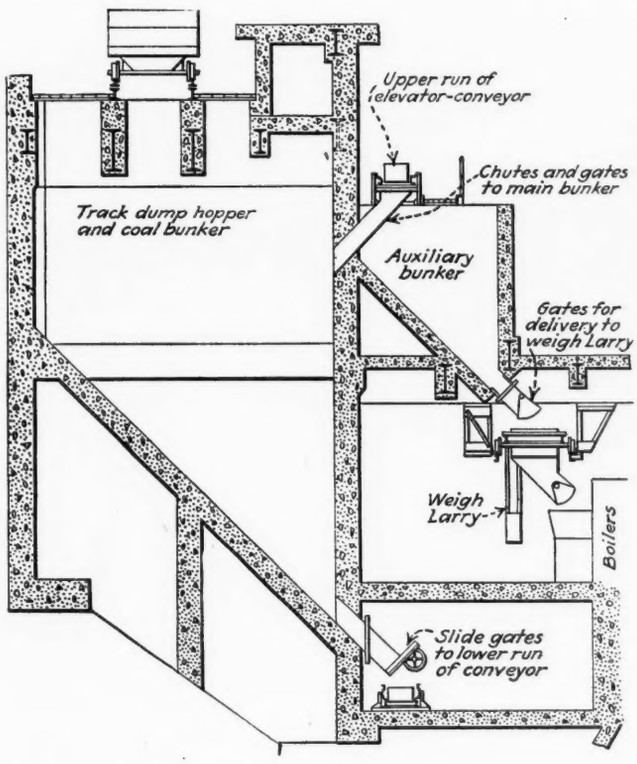
Artificial ventilation is provided from the seventh to the eighteenth floors. Except for a few special units, the indirect sections and fresh-air fans are at opposite ends of the building and in identical locations on the respective floors, to facilitate steam and electrical distribution. A common riser supplies all units in vertical line, and the power panel supplying the motors is centered on the twelfth floor. Certain isolated units serve the transformer room, kitchen, and elevator machine rooms. The exhaust fans are located in penthouses on the roof, and groups of these motors receive service from central power boards.

Water for the building, which is taken from the city mains, is filtered in three pressure sand filters, each of 15,000 gal. per hour capacity, and is forced to two storage tanks at the top of the tower by three electrically driven triplex pumps.

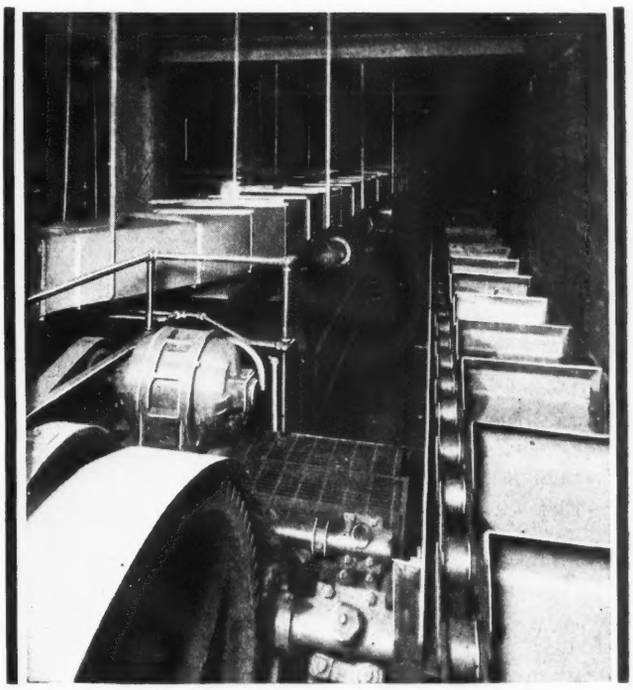
Fire protection is by a sprinkler system in which a pressure of 25 lb. is maintained at the highest sprinkler nozzles by a 1,500-gal. per minute motor-driven fire pump and three 25,000-gal. gravity tanks at the top of the tower.

The 15 passenger elevators are of the gearless traction variable-voltage type designed to carry a live load of 2,500 lb. at 600 ft. per minute. Two combination passenger and freight elevators designed for a live load of 4,000 lb. at 300 ft. per minute serve eighteen floors, and there are twelve freight elevators of the variable-voltage worm-gear direct-traction type that carry 8,000 lb. at 300 ft. per minute. Provision has been made for six additional elevators.

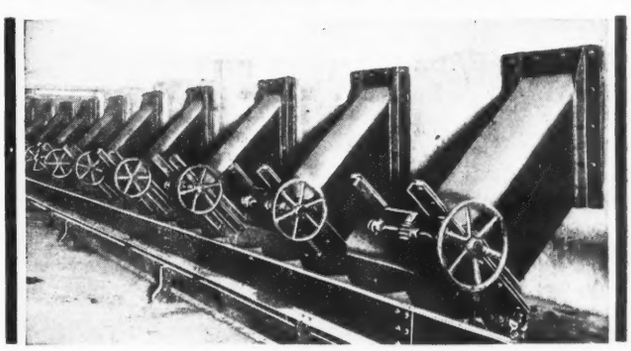
Electrical energy comes in at 12,000 volts to transformer vaults in the center of the building on the ninth


Upper run of elevator-conveyor
Chutes and gates to main bunker
Track dump hopper and coal bunker
Auxiliary bunker
Gates for delivery to weigh Larry
Weigh Larry
Boilers
Slide gates to lower run of conveyor

Cross-section of coal handling system



Above Right—Upper run of elevator-conveyor from drive end

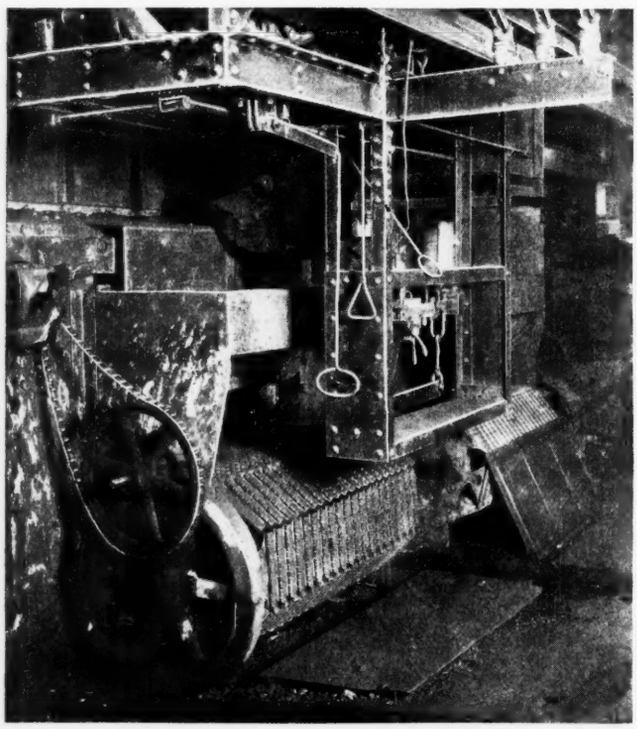


Below Right—View of gravity-discharge elevator-conveyor, showing slide gates from bunker

floor. Ultimately, there will be twenty transformers arranged in four banks of three transformers to step down to 440 volts for power, and eight single-phase transformers to reduce to 220-110 volts for lighting.

The motors, for the most part, are grouped to receive their service from a central power panel supplied by a feeder from the transformer vault.

Seven water-tube boilers are installed to supply the steam for heating, for hot water, and to drive the pumps. Five 5,050-sq.ft. boilers are in single settings, and two 2,500-sq.ft. boilers are arranged in a battery. The boilers are designed for 160 lb. pressure, but they



Traveling weigh larry in position to serve stoker

are operated at 100 lb. Standard brick settings are used, and the stokers are of the natural-draft traveling-grate type. A steel stack, 321 ft. high above the boiler-room floor and 10 ft. 8 in. in diameter, lined with vitrified asbestos, serves the seven boilers. Four steam-driven duplex pumps feed the boilers.

Returns from the building are brought back to a receiving tank from which the feed pumps draw their supply. The make-up is drawn from the filtered-water line and admitted to the receiving tank under float control.

Automatic control for the damper and for the steam supply to the stoker engines is in the main boiler breeching. Two of the engines are belted to a common line shaft driving all or any of the stokers.

A practical system has been arranged for the handling of coal and ash. Stoker-size bituminous coal is brought into the building in drop-bottom gondola cars at the ground level. The coal drops directly from the cars into the bunker through a grating which keeps out foreign material larger than 4 in. in diameter. The bunker extends the entire length of the boiler room. Through one or more of 39 rack-and-pinion-operated slide gates the coal is discharged from the bunker as needed into the lower run of an elevator-conveyor, which discharges to an auxiliary bunker.

The upper, or the discharge, run of the conveyor is supplied with eight rack-and-pinion-operated slide gates and chutes, with handwheels on the operating shafts for control from the walkway. Delivery to the auxiliary bunker is made through one or more of these gates.

Coal from the auxiliary bunker is weighed and delivered to the stoker hoppers by a 1,000-lb. self-propelled motor-driven traveling weigh larry. An undercut gate at the bottom of the weigh larry hopper is operated by the attendant from the boiler-room floor.

Should the coal begin to heat in the main bunker, it may be recirculated by withdrawing it into the lower run of the conveyor, elevating and conveying it, and then discharging it through the gates of the top run back into the storage bunker.

From the various boiler ashpits, the ashes are chuted through cast-iron gates directly into cars operated by the Chicago Tunnel Company. A branch of the tunnel is run underneath the boiler room so that a car can be placed under each ash chute.

Graham, Anderson, Probst & White were the architects and engineers for the building.

Keeping Oil Circuit Breaker Tanks Oil- and Gas-Tight

By E. K. Read
Circuit Breaker Engineering Dept.
Westinghouse Electric & Manufacturing Co.

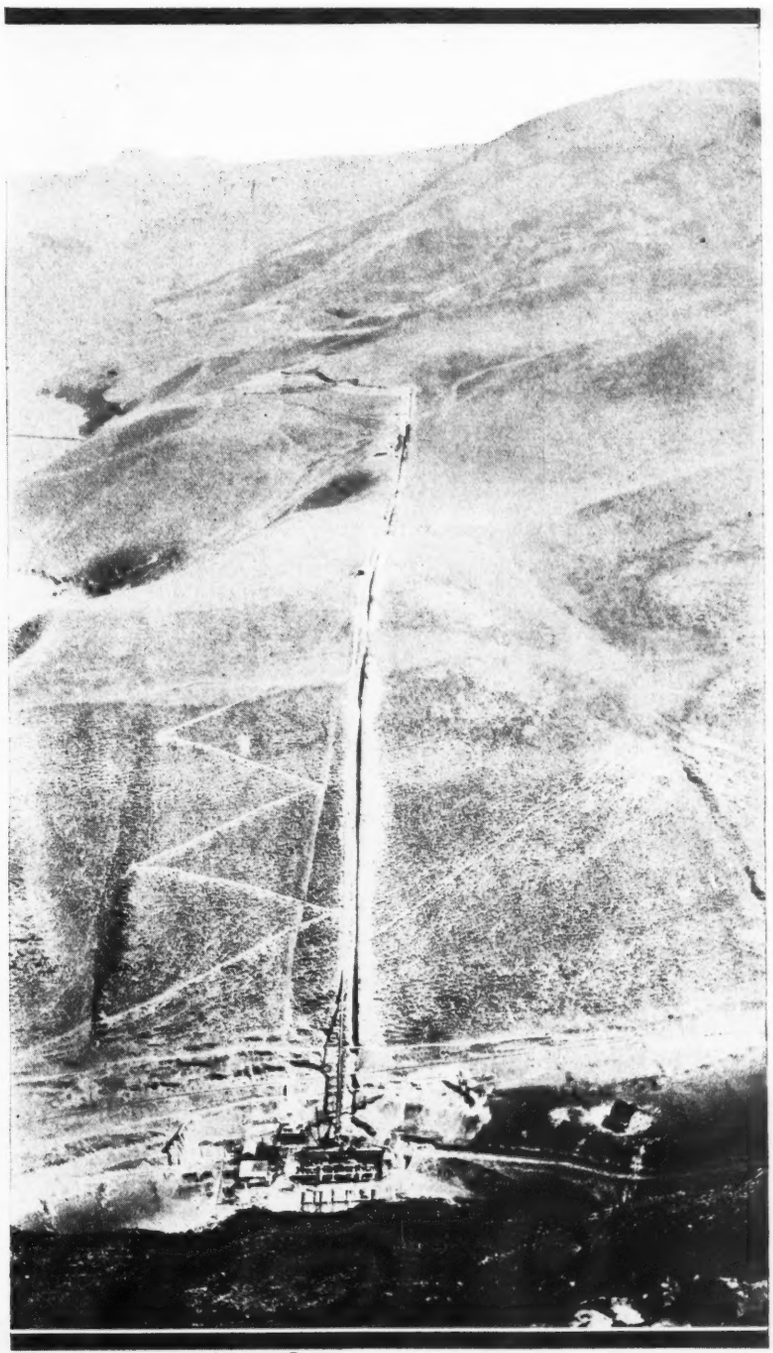
THE majority of operators pride themselves on maintaining a neat and orderly plant. Oil discharge from oil-insulated apparatus will spread over the sides of the equipment and on the floor, collecting dust and making a generally messy appearance. When circuit breakers interrupt short circuits they create a disturbance in their insulating oil. This may cause considerable pressure to build up in the tanks before the vents permit discharge of the gas generated by the arcing. If there is sufficient pressure a large volume of oil may be discharged.

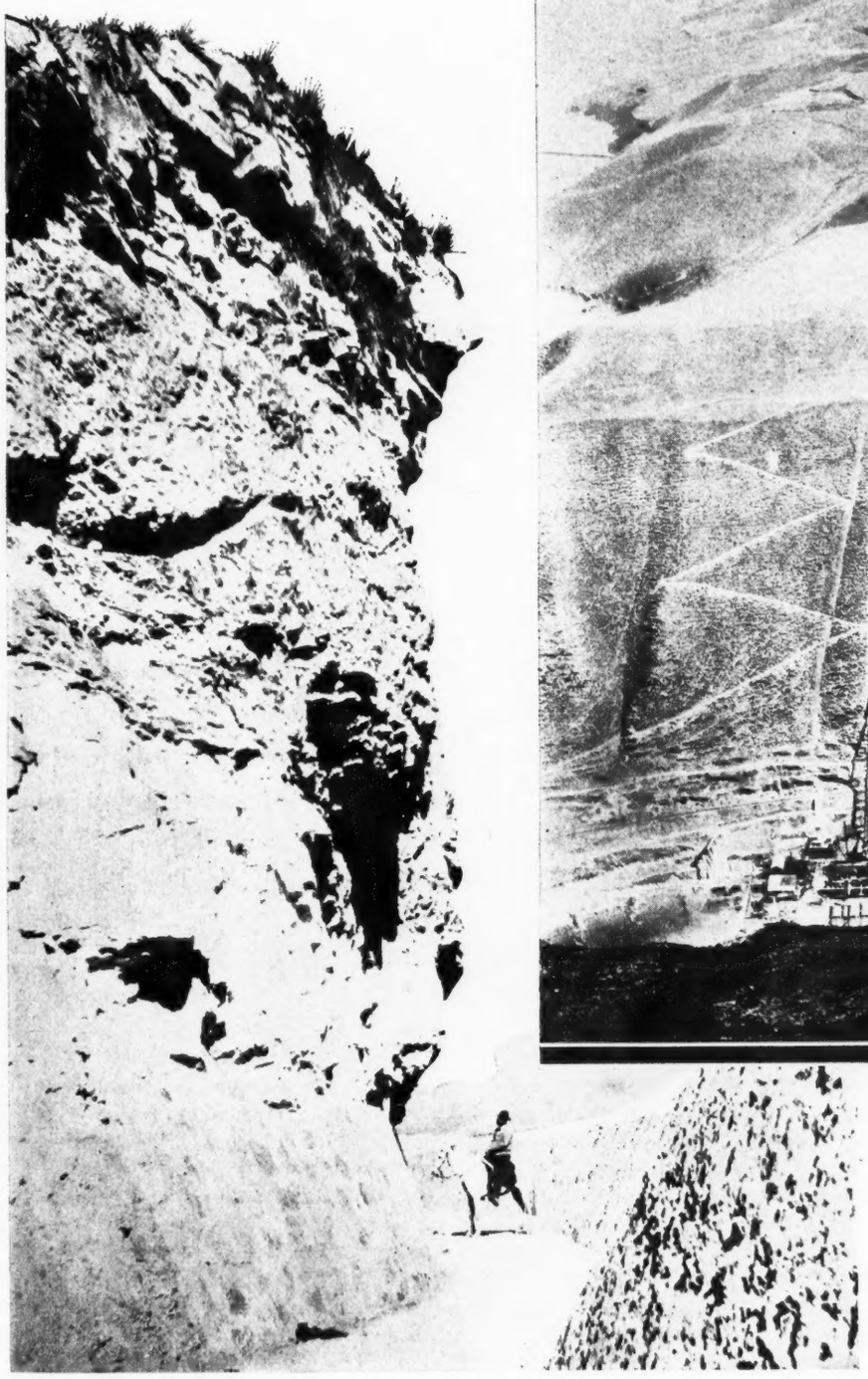
There are many types of packing to make the joints between the tank and the breaker's base gas- and oil-tight. Where the groove in the base and tank top are machined a comparatively hard packing is most satisfactory, inasmuch as the tank bolts can be drawn tight without danger of injuring the packing. When the junction is such that it cannot be machined, the packing must have considerable flexibility. Most flexible types of packing have a tendency to flow under pressure, the joint becoming less tight after a few hours. Packing of this type must be drawn up snug, allowed time to set slightly, and then tightened again to a final position.

A frequent cause of oil leaks is found in the drain valve at the bottom of the tank. Sometimes the valve is inadvertently opened, permitting a considerable quantity of oil to run out before it is discovered. It has been found desirable to use a standard pipe plug in the discharge of these valves to prevent any leakage either through the valve or by accidental opening. Oil gages should be checked to insure that the packing around glasses has not become loosened to permit oil leakage. On most gages the pressure can be renewed on the gasket with a pair of pliers or a wrench. A good coat of shellac on a gasket just previous to drawing the packing up will help to maintain it in a tight condition.

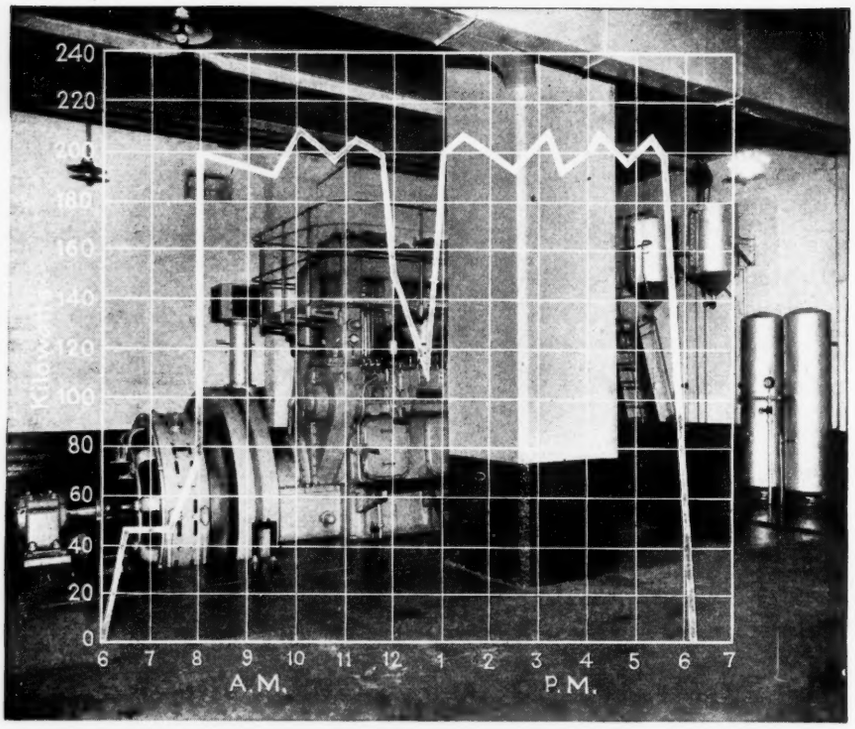
POWER IN THE ANDES

TRILLIONS OF RAINDROPS, falling on the high Andes, feed the mighty Amazon. Of these, a few are compelled to work their passage. Twelve thousand feet above sea on the Yauli River, an Amazon tributary, near Oroya, Peru, is this 20,000-hp. hydro plant (right) supplying power to copper mines in the wilderness. The head is 600 ft.





ON ITS WAY to the plant the water coasts along the mountain sides for 9½ miles, in the ditch shown at the left, and in 13,000 ft. of wood flume. Sea shells buried in the rocks remind one of prehistoric days when the available head was nil.



View of Diesel engine and the daily load curve

DIESEL-STEAM PLANT
in a Printing House

BY BRANSFORD W. CRENSHAW
Consulting Engineer, Associated With
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Interest being displayed in combined steam engine and Diesel power plants prompts this discussion of the Diesel addition to the steam engine power plant of the Irving-Pitt Manufacturing Co., Kansas City, Mo. This step was taken only after a thorough analysis of the situation and of possible power sources

IN THE spring of 1928 the Irving-Pitt Manufacturing Company, of Kansas City, Mo., manufacturers of loose-leaf books, ledgers, and devices, was faced with a probable power shortage in the near future. The power demands of the factory had begun to tax the capacity of the steam power plant, and it was necessary to make plans for augmenting the available supply. There were several possible solutions, including enlargement of the steam plant, purchase of all or a part of the power required for the factory, or installation of a Diesel engine unit.

The analysis of these possibilities, the results of the analysis, the installation of a Diesel engine, and the operating results of the plant comprise the subject matter for this article.

A power plant was first installed by the Irving-Pitt Manufacturing Company in 1921: A combination heating and power-generating plant. Principal equipment consisted of three 72-in. x 18-ft. horizontal return-tubular boilers built for 150-lb. pressure and equipped with side-feed V-type stokers, and an 18x18-in. four-valve steam engine direct connected to a 150-kw. direct-current, 3 wire, 125-250 volt, compound-wound generator. In addition, there were a feed water heater, boiler feed pumps, ice machine, air compressor, zeolite water softener, meters, and other auxiliary equipment.

Most of the auxiliaries and other equipment, such as the ventilating fans and the compressor, were steam driven, as exhaust steam was used for heating as well as for some process work. In addition to the low-pressure exhaust steam used for processes, there is other equipment in connection with the manufacturing that requires steam at about 45-lb. pressure. This fact was

of considerable importance in the analysis to determine the type of prime mover to be installed.

Consumption of current in the factory continually increased until in 1924 the overloading of the original generating unit and the desire for stand-by service necessitated an additional generating unit. At that time the company purchased a second steam unit which solved the problem for the time being.

In 1928 the normal load during operating periods had reached 800 amp., with peaks as high as 1,100 amp. With this load the plant operation depended upon the running of the large unit, as the smaller one could not carry the load and the company did not wish to face the possibility of a factory shutdown due to power plant failure.

The boiler plant was also overloaded. Oil and pulverized fuel equipment had previously been installed in two of the boilers to increase their capacity, but when one boiler was down for cleaning or repairs the others had to be operated at high ratings to carry the load, which increased maintenance costs. Also the boiler insurance company had notified the management that the maximum pressure allowed on the boilers would be reduced from 150 to 140 lb. in 1930, which would have made the situation much worse.

Therefore, the problem that confronted the company in 1928 was to insure uninterrupted service, to provide for at least five years' normal growth, to expand in such a way that future additions would be easy, to reduce operating costs, and to make the changes without interrupting service.

In considering the analysis it must be remembered that this is an isolated plant in a factory usually operated only during the day. The generating units are not run during the night, there being no lights used in the building after it is closed.

A preliminary investigation indicated that if the steam plant were to be enlarged, the new equipment should consist of a uniflow engine direct connected to a 300-kw. generator, and a 3,500-sq.ft. water tube boiler. Such an installation would necessitate a number of building alterations, and it was estimated the total cost of the complete extension would be approximately $52,000.

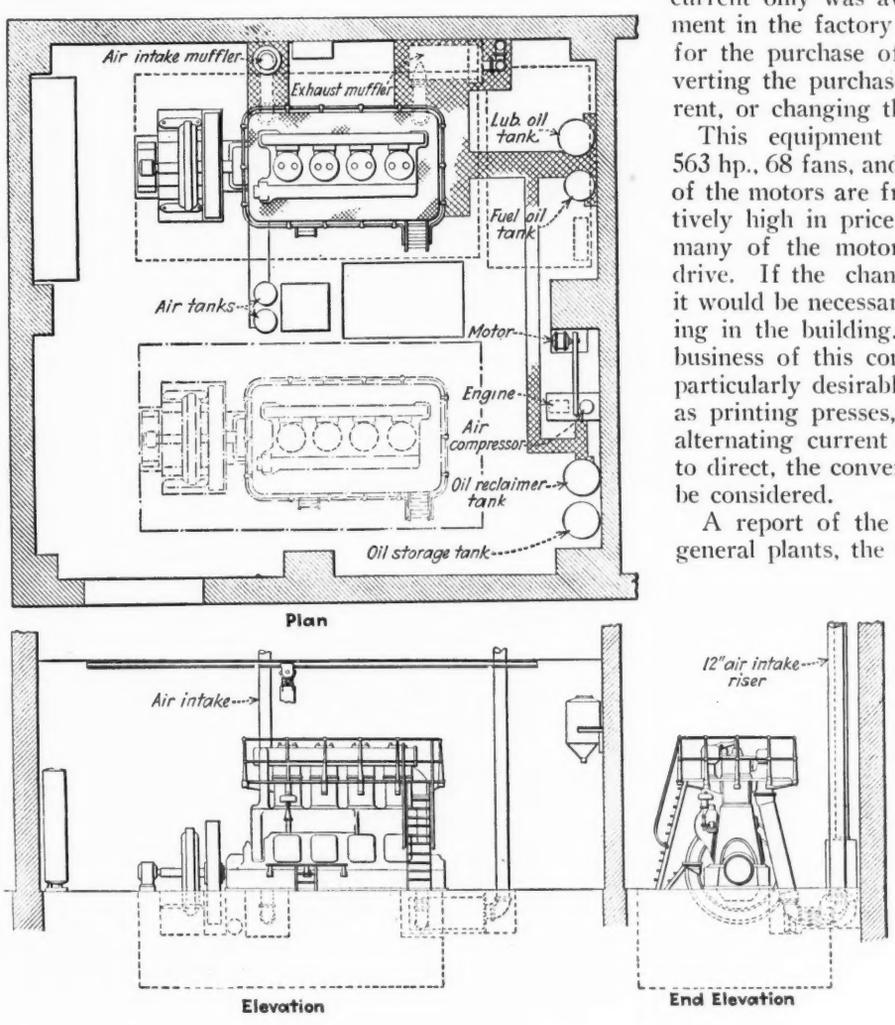
This addition to the steam plant would provide stand-by service and insure uninterrupted operation, as the three old boilers and the old generating units could be held in reserve, but space requirements for any additional expansions would be costly. However, there was another important consideration in dealing with the question of the advisability of the steam plant: Steam requirements for the heating of the building and for process work had remained practically fixed for some time, while the power consumption had been constantly increasing. Therefore the plant was decidedly tending toward power generation rather than steam generation.

Operating costs of an expanded steam plant would have been practically the same as in the past, except that the fixed charges on the new equipment would have increased the total.

The matter of purchased power was gone into rather thoroughly. It could supplant either wholly or in part the power generated in the company plant. Alternating current only was available for purchase, and all equipment in the factory was for direct current; so any plan for the purchase of power had to consider either converting the purchased alternating current to direct current, or changing the equipment in the factory.

This equipment consisted of 246 motors totaling 563 hp., 68 fans, and miscellaneous office machines. Most of the motors are fractional horsepower, which are relatively high in price and have little re-sale value. Also many of the motors are built into the machines they drive. If the change to alternating current were made, it would be necessary to rebuild much of the power wiring in the building. The nature of the manufacturing business of this company is such that direct current is particularly desirable for many of the applications, such as printing presses, ruling machines, elevators, etc. If alternating current should be purchased and converted to direct, the conversion loss of about 9 per cent was to be considered.

A report of the local power company covered three general plants, the first of which was based upon using



Plan and elevation of the engine room, showing locations of the auxiliary

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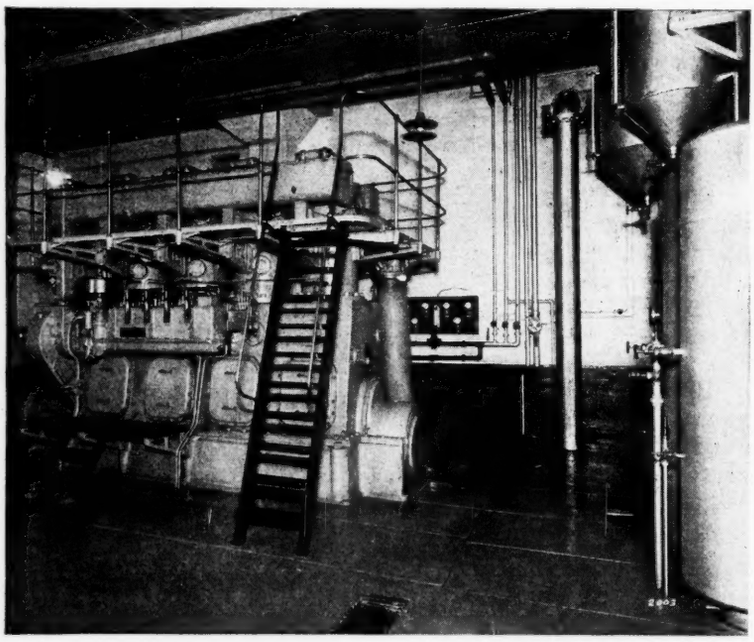
purchased current twelve months of the year, buying it at 13,200 volts, to be stepped down in a transformer station owned by Irving-Pitt and changed to direct current by a rotary converter. A suitable substation for such usage would have cost approximately $15,000.

Under this plan, basing estimates on current generated in the plant during 1927, the annual cost of current would have been about $9,061, to which would have been added the fixed charges on the $15,000 new investment necessary, amounting to $2,550, making a total annual cost of purchased current of $11,611.

Purchase of this power would, of course, reduce operating expenses in the company plant. The cost of coal burned would be reduced from $13,126 to approximately $7,000, due to the fact that during the summer months when no steam for heating was being used the engines would not be exhausting to atmosphere. During those months one boiler would furnish all of the steam necessary for process work, and it could be fired partly with trash. Labor charges would be reduced. When operating the steam plant five men are required in the boiler and engine rooms, and two for building maintenance; whereas with the generating plant shut down, two men and the superintendent in the boiler and engine rooms and one for building maintenance would be all that would be required. The saving would be about $5,000 a year in both departments, or about $3,000 in the power and heating plant.



The Diesel engine and the oil tanks

Water costs would be reduced to about $100 a year, supplies reduced to $1,000, and ash hauling to about $200. Considering also the annual revenue from sale of current to other building tenants, total annual costs under the purchased power plan would have been approximately $37,591, as contrasted with the actual 1927 costs of $37,114. Thus this plan would have been slightly more expensive than the then operating system, but probably cheaper than an expanded steam plant, because of the higher fixed charges on the increased steam plant.

In all of the possible plans considered, fixed charges on the old equipment were included. This was done for two reasons: first, the equipment has little or no re-sale value; secondly, it was desired to retain the generating units for stand-by service, and the boilers are needed for supplying steam.

The second of the three plans proposed by the power company for purchasing power was through the same type of substation but using purchased power only eight months out of the year. The factory plant would then furnish current during the four cold winter months when a greater part of the exhaust steam could be used for heating. Under this plan the monthly demand charge of $381 would have to be paid to the power company the whole twelve months, and current would be available for stand-by service. Using power in this way, the annual cost would have been about $37,904, which was nearly the same as the first purchased-power plan.

The last of the three purchased-current plans contemplated furnishing a part of the factory with alternating current, where the change of equipment would not have been expensive and where direct current was not particularly desirable, and furnishing the remainder of the factory direct current through a motor-generator set. The cost of new equipment and changes for such an arrangement, including primary substation, 100-kw. motor-generator set, 29 induction motors totaling about 150 hp., new wiring, and seven new buffing machines, would have been about $23,000.

While this plan might have effected some current saving due to elimination of conversion losses, the fixed charges on the additional equipment would have practically offset the savings. There would have been the disadvantage of having two kinds of current in the factory, with consequent accidents and delays in shifting machines. Another serious drawback was that the changing of part of the plant equipment for alternating current would tend to preclude the future generation of power if that seemed advisable.

The third and last of the three general plans for increasing the plant capacity involved a Diesel-engine installation. Preliminary studies indicated that a 275- or a 300-kw. unit would take care of the power requirements for five years. During the heating months the steam units could be counted on for a part of the load. The summer loads were naturally somewhat lighter than the winter, the average for the summer months being about 165 kw., with peaks not in excess of 210 kw. Considering the possibility of carrying peaks of short duration with a 25 per cent overload on the units, the maximum peak that could be carried on the 275-kw. unit would be 343 kw., or 63 per cent in excess of the then summer peak. The power consumption increase expected was about 10 per cent a year, so this size unit would probably take care of five years' expansion.

The probable schedule of operation of such a plant called for the generation of all power during the summer months by the Diesel unit. Steam requirements during this period usually ran about 1,200 lb. an hour, a large part of which was at 45-lb. pressure. One of the old boilers, which still was equipped with a Murphy furnace, would be used to supply the steam, burning trash and coal. It was expected that when the heating season started enough power would be generated by the steam engines to supply sufficient exhaust steam to heat the buildings. This heating steam would probably generate

from 75 to 150 kilowatts per hours during the day.

Upon this basis the amount of coal burned, the labor, the water, supplies, and ash handling would be practically the same as under the first plan for using purchased power. It was estimated that fuel oil for the Diesel engine, lubricating oil, and engine maintenance would total about $2,792 a year. The fixed charges on the old plant amount to $12,108 annually, while those on the estimated cost of the proposed addition would have been $6,290. These figures, after making a deduction for power sold, showed a total annual operating cost of approximately $35,062, which was a saving of $2,529 a year over the estimated total operating cost of a plant using purchased power, and also a saving of more than $2,000 over the previous year's operating costs.

With this estimated saving, the only remaining question was whether or not the Diesel plant would fufill the requirements. With the Diesel unit, complete stand-by service would be available, as the boiler plant would always be ready to provide process steam or heat. Five years' normal growth in power consumption would be provided for. Future extensions would be easy. Operating costs would be reduced. The change could be made without interfering with the operation of the factory. Evidently, all five requirements could be met by a Diesel plant.

Another consideration was that a large portion of the total cost of generating current with the Diesel unit was fixed cost, and a part of the expense charged to this head would be returned to Irving-Pitt to retire the investment. As the Diesel would be written off in seven years, the charges set up really carry an excess, representing an additional saving.

The tabulated cost analysis prepared at the time are given in Table I.

In view of the facts brought out in this analysis, $40,000 was appropriated to install a Diesel engine generating unit. After some further study, it was decided to purchase a 400-hp. Diesel direct connected to a 275-kw. direct-current generator, together with all necessary auxiliaries and equipment. Proposals were received from a number of engine builders, and the unit finally purchased was a De La Vergne four-cylinder, 400-hp., 225-r.p.m., four-cycle, solid-injection Diesel direct connected to a Burke 275-kw. direct-current, three-wire, 125-250-volt, compound-wound generator. The matter of vibration was given considerable thought. The Irving-Pitt factory is on the edge of the retail business district of Kansas City, is directly across the street from the main public library, and there are a number of hotels within a radius of two blocks. Therefore, it was essential that there should be no noticeable vibration or noise in connection with the operation of the unit.

There were also several other limitations that made the installation rather difficult. The work was not to interfere in any way with the operation of the existing power plant, or any of the manufacturing operations of the company. The only means of getting the new equipment into the engine room, which was in the sub-basement of the building, was down the elevator shaft, and there would only be a few inches clearance with the largest piece. Also it was found that there would probably be only about two inches' total available clearance between the building column footings and the engine foundation. The headroom clearance above the space needed to pull pistons was only about one inch. These close dimensions made it advisable to make full-sized templates of the engine and auxiliaries and lay them out on the engine room floor to check clearances. This was done.

To guard against vibration, the foundation pit was excavated to rock at a depth of seven feet, and the sides and bottom of the excavation were lined with concrete. Then the whole pit, sides and bottom, was lined with a two-inch layer of cork block, over which was placed tar paper. Concrete for the engine foundation was then poured into the pit. Average bearing pressure on the bottom of the foundation is about 1,000 lb. per square foot. This precaution may not have been necessary, because after the unit was started there was very little vibration, none that could be distinguished outside of the foundation.

Accessories included with the installation were: A gasoline-engine-driven compressor with tanks, overhead fuel tanks, oil reclaimer, cooling tower and pumps, air filter, intake and exhaust mufflers, and a trolley hoist.

The air intake is in the engine room, and was so located to ventilate this room. Provision was made so that air could be taken from outside of the building if it was found desirable in the winter months.

It was necessary to run the exhaust line to the roof. No objectionable intake noise is noticeable in the engine room, and even when standing on the roof next to the exhaust it cannot be heard. The exhaust muffler is buried under the engine room floor.

Space limitations called for a rather unusual arrangement of the cooling system. The only space available for the cooling tower was on the roof of the building, and the only practical location for a cold-water tank was over a large vault on the sixth floor. The headroom above

TABLE I—PROPOSED OPERATIONS COMPARED WITH ACTUAL OPERATIONS FOR 1927

	1927 Costs Steam Plant	Purchased Power				Diesel Engine Plant
		Plan A	Plan B*			
			4 Winter Months	8 Summer Months	Total for Year	
Coal	$13,126.46	$7,000.00	$5,448.59	$3,000.00	$8,448.59	$7,000.00
Wages, engineers and firemen	9,511.42	6,760.00	3,344.60	4,420.00	7,764.60	6,760.00
Water	166.88	100.00	56.23	50.00	106.23	100.00
Generators:						
Depreciation 9 per cent	1,944.00	1,944.00	648.00	1,296.00	1,944.00	1,944.00
Interest on investment, 6 per cent	1,296.00	1,296.00	432.00	864.00	1,296.00	1,296.00
Insurance and taxes	228.00	228.00	76.00	152.00	228.00	228.00
Other light & power equipment:						
Depreciation, 7 per cent	2,667.36	2,667.36	889.12	1,778.24	2,667.36	2,667.36
Interest on investment, 6 per cent	2,300.64	2,300.64	766.88	1,533.76	2,300.64	2,300.64
Insurance and taxes	300.00	300.00	100.00	200.00	300.00	300.00
Heating plant:						
Depreciation, 6 per cent	1,536.00	1,536.00	512.00	1,024.00	1,536.00	1,536.00
Interest on investment	1,536.00	1,536.00	512.00	1,024.00	1,536.00	1,536.00
Insurance and taxes	300.00	300.00	100.00	200.00	300.00	300.00
Supplies	2,938.41	1,000.00	1,110.85	500.00	1,610.85	1,000.00
Hauling ashes	452.12	200.00	181.12	100.00	281.12	200.00
	$38,303.29	$27,168.00	$14,177.39	$16,142.00	$30,319.39	$27,168.00
Additional Equipment:						
Depreciation, 10 per cent	.....	$1,500.00	.....	.....	$1,500.00	$3,700.00
Interest on investment, 6 per cent	.....	900.00	.....	.....	900.00	2,220.00
Insurance and taxes, 1 per cent	.....	150.00	.....	.....	150.00	370.00
Power-purchased	.....	9,061.80	.....	$4,700.00	4,700.00	.....
Stand-by charges	.....	.....	$1,524.00	.....	1,524.00	.....
Fuel and lubricating oil	.....	.....	.....	.....	.....	2,432.80
Maintenance	.....	.....	.....	.....	.....	360.00
	$38,303.29	$38,779.80	.....	.....	$39,093.39	$36,250.80
Credit, power sold	1,188.57	1,188.57	.....	.....	1,188.57	1,188.57
Net cost of operation	$37,114.72	$37,591.23	.....	.....	$37,904.82	$35,062.23
Saving through use of oil engine	$2,052.49	$2,529.00	.....	.....	$2,842.59	.....

*Using purchased power during 8 months and generating power in winter.

the vault was only five feet, and rather inaccessible, so the tank had to be fabricated in place. The cooling tower was placed just above the tank, a hole being made in the roof to allow the water to fall from the tower to the tank. Cooling water flows from the tank on the sixth floor to the engine in the sub-basement by gravity through a reducing valve. After it leaves the engine jacket it drops to a hot well beneath the engine room floor, from where it is picked up by a centrifugal pump and forced to the cooling tower on the roof.

Total cost of the complete installation was approximately $41,100.

When the Diesel plant was first considered, it was expected that the steam engines would be used to generate a considerable part of the current during the winter months, using the exhaust steam for heating the buildings. However, after operation was started the costs were found to be such that it would be more economical to generate all of the current with the Diesel unit rather than go to the additional expense of operating the steam engines except in emergencies, and this has been the plan of operation up to the present time.

The operating costs for both the heating and power plants for 1929 were accurately kept. The results are given in Table II.

TABLE II—OPERATING COSTS IN 1929

Heating Plant Costs		
Coal	$5,135.05	
Boiler fuel oil	314.16	
Heating-plant labor	4,481.22	
Repairs and lubricating oil	391.30	
Total		$10,321.73
Diesel plant costs (506,760 kilowatt hours generated)		506,760
Fuel oil, 54,775 gal	$1,983.99	
Diesel plant labor	3,789.87	
Lubricating oil and repairs	410.61	
Total		$6,184.47
		$16,506.20
Fixed charges on old equipment		12,108.00
Fixed charges on new equipment, @ 16 per cent		6,576.00
Total annual costs, combined plants		$35,190.20

Actual operating costs of the Diesel plant amounted to $6,184.47, giving an operating cost per kilowatt-hour of $0.0122 for the year. Preliminary estimates made on the operation cost of this type of plant showed a total annual cost of $36,250.80, which is $1,060.60 more than the actual figures for the year.

The facts, cost figures, and other data contained in this article were furnished the writer by Marshall Dana, formerly with the Irving-Pitt Manufacturing Company, and Frank R. Hunter, chief engineer of that company.

Placing a Flooded Induction Motor in Operation

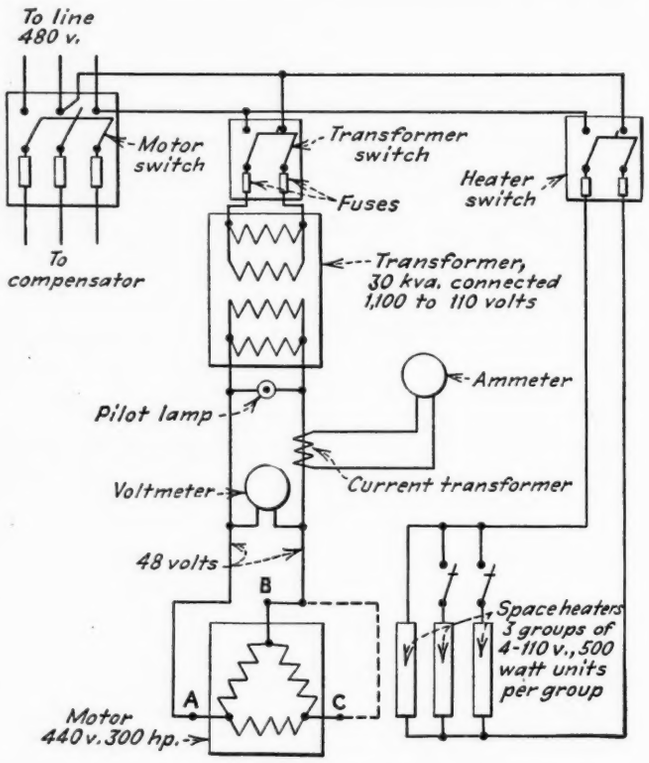
By Arthur May
Bakersfield, Calif.

DUE to clogging of a screen, brackish water overflowed into a pit in which a 300-hp. 440-volt induction motor was in operation. About 10 per cent of the winding in the bottom portion of the motor was submerged. The motor was stopped before the water reached the squirrel-cage rotor, hence the entire stator winding was not wetted. The portion of the winding affected was under water for thirty minutes.

It is well known that a motor with wet insulation cannot be operated without risk of serious damage, yet in this instance circumstances demanded immediate operation so that production could be resumed. No equipment, such as a megohm meter or a direct-current voltmeter, was available for determining to what extent water had penetrated the insulation. Since only a small part of the winding had been submerged, it was preferable to risk its failure and immediate replacement, rather than to undertake to dry the insulation.

The motor was started shortly after the pit was emptied. A few seconds after being transferred from the starting to running voltage, and before load was applied, two muffled explosions were heard, and flame and smoke issued from the wet section of the winding. The compensator was at once thrown to the "off" position. No protective equipment functioned. Indications were that serious trouble had developed, therefore the end bells and rotor were removed to permit of a careful examination. No evidence of burning, arcing, or breakdown could be found; but considerable moisture was present.

By this time a megohm meter had been procured, and the motor's insulation resistance was found to be low,



Connections for drying the induction motor

30,000 ohms. A few weeks previously the insulation had shown 800,000 ohms. Preparations were at once made to dry it.

A discarded 30-kva. 2,200 and 1,100- to 220 and 110-volt single-phase transformer was connected as shown in the figure. The 1,100- to 110-volt connection was used, 48 volts being applied to two of the three motor terminals. With this connection the current was 215 amp. Thermometers were placed on the top and bottom sections of the windings, their bulbs being covered with steam-pipe insulation made plastic with water. The motor was covered with canvas (the most available material) except for an opening at the top for the escape of moisture. Several carbon-tetrachloride fire extinguishers were placed near by.

The current of 215 amp. heated the motor slowly. Therefore the current was increased to 300 amp. by connecting motor terminal *B* to *C*, as shown dotted in the figure. To hasten the drying process twelve 110-volt, 500-watt space heaters were arranged in three groups of four in series, and were connected to the power circuit. The heating units were supported by wire inside the motor, spaced six inches from the winding or the laminations.

While arranging the space heaters a number of pockets in the ventilating spaces between groups of laminations were found filled with water. This water was in contact with the slot insulation. It was blown out of the pockets by compressed air. Probably the water would not have been found, and could not have been removed, if the rotor had not been taken out.

With 300 amp. flowing and all twelve space heaters energized the temperature of the surface of the windings increased from 22 to 80 deg. C. in four hours.

The megohm meter readings obtained are given in the table. Evidently the water had not penetrated the insulation when reading 1 was taken. Reading 2 was very low, and indicates that the insulation had become water-soaked. Beginning with reading 5 the insulation resistance increased in a most remarkable manner. In a period of 5½ hr., during which all heating current was off, and while the winding was being painted and the motor assembled, the insulation resistance increased from 45,000 to 290,000 ohms.

INSULATION RESISTANCE READINGS TAKEN ON 440-VOLT, 300-HP. INDUCTION MOTOR

Hour	Reading Number	Average Temp., Deg. C.	Ohms	Remarks
0	0	.....	.....	Motor flooded
6	1	21	30,000	First megohm meter reading
10	2	22	9,000	215 amp. applied
27	3	45	15,000	Motor had cooled
49	4	80	9,000	300 amp. and heaters on (31st hr.)
57	5	80	20,000	.....
71	6	75	45,000	All heat off. (71st hr.)
73	7	45	90,000	Motor being painted, assembled
73.5	8	35	125,000	and made ready for operation
74	9	35	150,000	
74.5	10	35	200,000	
76.5	11	30	290,000	Motor in operation (76.5 hr.)

Had not an insistent demand been made for this motor to go into service, it should have been dried until its hot insulation resistance increased to 600,000 ohms, but in this case the drying process had to be curtailed. When the motor was ready for operation its cold insulation resistance was 290,000 ohms. Had the motor's insulation been well impregnated and sealed so that moisture could not readily enter, it is quite probable that operation could have been resumed without drying. Further, the water found in the pockets in the ventilating spaces would most likely have been dissipated by the motor's own heat and windage in a short time. But one cannot be sure of these matters, hence a flooded motor should be kept out of service until dried. In this way future troubles will be avoided.

The flame and smoke that appeared when the motor was first started seem to have been due to leakage across the wet fullerboard, which was between untaped bar conductors in the end windings of certain coil groups. Full potential, 480 volts, was impressed across this moist material, which, forming a conducting path, caused a flashover, with resultant flame and smoke. This flashover caused no permanent damage.

As to the method of drying used (internal and external heat) had means been available to direct a blast of air at a temperature of 95 to 100 deg. C. over that portion of the winding known to be wet, rapid drying would have resulted without removing the rotor, and another source of heat would not have been necessary

▼ ▼ ▼

SELECTING FUEL

For Pulverized-Coal Installations

By C. H. CAMP
Combustion Engineer
W. A. Marshall & Company

An analysis of coals with respect to their suitability for use in pulverized-fuel installations from an efficiency standpoint. It should be kept in mind that the ultimate cost of making a unit of steam is the single consideration that should govern fuel selection

THERE is a wide variation in results of burning pulverized coal under boilers. Some erroneous ideas from earlier days, still extant in some quarters, are to a large extent responsible for this. One belief quite prevalent is that in a pulverized-coal plant any coal can be burned successfully. So strong has this become that it amounts almost to a slogan. It is incorrect, because it is incomplete. Efficiencies below the point justifying investments; excessive furnace upkeep; high grinding and grinder maintenance costs; smoke and fly-ash troubles are as much the results of improper selection of coal as they are due to improper design.

It is true that there are many remarkably successful pulverized-fuel installations burning grades of fuel all the way down to lignite. Particularly successful are several lignite installations in Texas, but these are specially designed throughout, even to the extent of special spacing of tubes in lower sections of boilers to prevent an excessive amount of slag bridging across them. It would be more correct to say of pulverized-coal installations that, while any grade of coal can be burned in them, each plant, according to the fuel it is designed for, has a definite range of coals that must be observed, if

efficiencies, grinding costs, upkeep charges, and smoke and fly-ash troubles are to be kept where they should be.

As installations for lignite or anthracite are comparatively few and the various fields from which each of these fuels is mined possess almost identical characteristics from a pulverized-fuel standpoint, this article will deal only with the almost universal bituminous plants.

It is the general belief that the higher the volatile the more suitable the coal. This is entirely incorrect. The psychology of this is easily understood, because gas is mostly made from high-volatile coal and it can be burned easily and completely. Also, the combustion of pulverized coal closely resembles, visually, that of gas.

When using pulverized coal, gas and solids are burned simultaneously. In other methods of coal burning combustion takes place progressively in different zones that are equipped to suit the combustion requirements of each element in turn.

To secure complete combustion of a combination solid and gas in the shortest time the best relative proportions and the proper characteristics of each element should be determined. Time is as important a factor in combustion as any other element. It is paramount in a pulverized coal furnace, because in even the largest of such furnaces the time-distance from burner to boiler is less than the height from fuel bed to boiler in average solid-fuel settings.

It is necessary from a combustion efficiency standpoint to get combustion completed as quickly as possible. And as water- and air-cooled walls are reducing furnace volume to more commercially desirable limits the need for lessening the time-distance of combustion is correspondingly increased.

FAST FLAME PROPAGATION ESSENTIAL

To obtain rapid combustion it is obvious that fast flame propagation is essential. This depends primarily on the ignition point of the fuel. The ignition point of the volatiles distilled from coal is always higher than the ignition point of the fixed carbon constituent, although they are distilled off before that point is reached. It is the heat of combustion from the fixed carbon that ignites the volatile gases. The ignition point for the fixed carbon in the various classes of coal are, for bituminous coals, 766 deg.; semi-bituminous coals, 870 deg.; anthracite coals, 925 deg.[1] So from the standpoint of ignition a true bituminous coal is desirable.

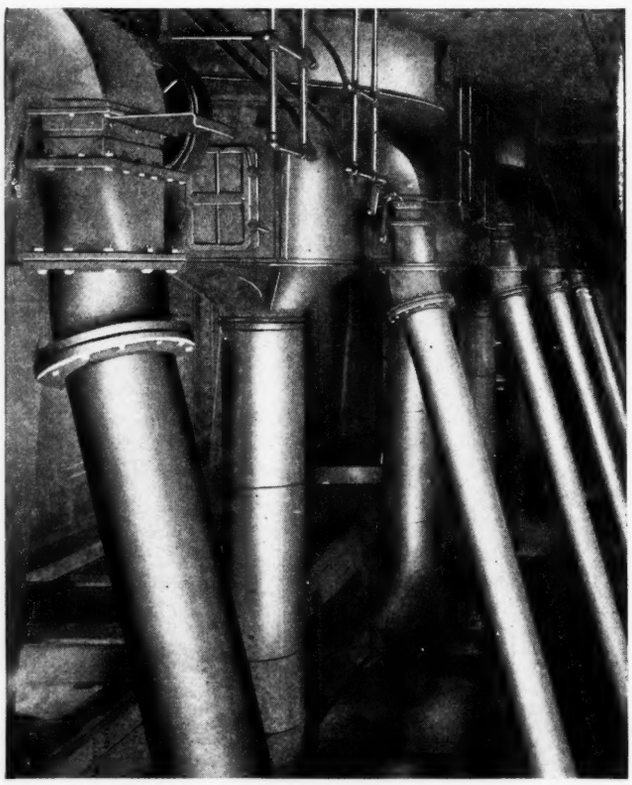
Once combustion of the fixed carbon is started the heat produced causes ignition of the various volatiles, the ignition points of which vary from 900 deg. to somewhat over 1,200 deg. for all those of any appreciable quantity. From that point on the higher heat of combustion of the volatile speeds up and sustains the burning of the solids.

It is obviously desirable, for rapid combustion, to have as low an ignition point as possible, and in the combination of solids and gas it is desirable from the ignition standpoint to have less of the higher ignition element. High-volatile coals do not meet this requirement.

Getting the proper amount of oxygen to all the combustibles is the greatest problem in combustion. Inert nitrogen, 76.85 per cent by weight, is in the air, acting as a defeatist. As oxidization of the solids takes place a film of CO_2 gas is formed, a barrier that tends to prevent oxygen from reaching unburnt fuel. As the live volatiles, of which the greatest proportion is in the outer areas of the flame, combine with oxygen, it is obvious, when secondary air is used, that the problem of getting oxygen to the solids, the greater proportion of which is at the core, increases in proportion to the increase in volatile. When using primary air exclusively it tends to spread out away from the core as it issues from the burner into the high temperature zone, and furthermore it mixes more readily with the volatile gases.

Further accentuating the difficulty is the inert matter in the volatile. This is usually negligible in medium- (20 to 27 per cent) or low-volatile (below 20 per cent) coals. Its percentage is almost invariably high in high-volatile (over 27 per cent) coals. This inert matter also wastefully absorbs heat.

It may be well to state here that while these classifications of low,- medium,- and high-volatile coals may seem arbitrary and not in accordance with some others, they are the classifications most generally used. In any event, they serve the purpose of this article. It may also appear that the specific percentages given declare a too definite critical point, as one might state the melting point of a substance. In many tests and observations it has been shown that definite changes in performance take place when a lower than 20 or higher than 27 per cent volatile coal is used. As a matter of fact the best performances have been with coals having a range of volatile content from 22 to 25 per cent.



Coal preparation room of a large utility

Another difficulty in combustion of gases is that of stratification. It is hard to prevent even when air and combustible gases only are present. As more inert matter is added the tendency to stratification increases until the point is reached with high-volatile coals where it is imposible to eliminate it altogether, with the result that a certain amount of volatile, which may be large, is in an area deficient in oxygen. Volatile in such a reducing atmosphere at operating furnace temperatures

[1] Babcock & Wilcox Co. *Steam.*

breaks down into heavier hydrocarbons and soot, which are difficult to burn. Stratification will, of course, also occur with low- or medium-volatile coals when the air proportioning is incorrect or if there is insufficient turbulence.

Of as great importance as the previously stated objections is the fact that with rare exceptions high-volatile coals are of a hard structure. Fine grinding is extremely difficult and the cost is high, with corresponding increase in grinder maintenance.

However, although high-volatile coals are not the most desirable, a certain percentage of live volatile matter, due to its higher heat of combustion, is highly beneficial for speeding up the burning of the solids, which is important because of the short time-distance in which it has to be done. There should be enough of live volatile to maintain a high flame temperature until the solids are completely burned. Then the solids need to be fast-burning enough to be wholly burned by the time combustion of the volatile is near completion.

Balance is the thing to be sought for in the combustion of the two elements, and this combustion should be completed in the shortest possible time-distance. This occurs in coals having a range of from 20 to 27 per cent volatile content.

The importance of shortening the time-distance of combustion necessitates the use of a coal with a fast flame propagation—the faster the better. Coals having the same volatile content vary greatly in this particular.

STABLE FLAME INDICATES GOOD COMBUSTION

The character of the flame is an indicator of proper flame propagation and efficient combustion. For horizontal firing best results are obtained with flames that are stable and not more than 4 to 5 ft. in length at moderate ratings. Stabilization of flame is a characteristic of good combustion. It is almost impossible to maintain with high- or low-volatile coals, and cannot be obtained at all with coals having slow-burning characteristics.

Long, flickering, or pulsating flames, or floating, partly burned solids, are characteristic of poor combustion. High-volatile or slow-burning coals usually produce these results. With low-volatile coals large amounts of floating, partly burned solids are almost invariably observed, due to the lack of sufficient volatile, with its high heat of combustion, to accelerate the burning of the solids long enough. Deficiency of air or poor mixing of air with combustible will also produce the same results.

Long flames result in impingement and damage to rear walls. When this occurs it is usually found that a high-volatile coal is being used, although it can be brought about with lower-volatile coals by having the velocity of the mixture in excess of flame propagation or by the use of an excess portion of secondary air.

Moisture is another element in coal that in pulverized installations reduces combustion efficiency a great deal more than it does in other methods of firing. Not only is the usual combustion loss sustained, but ignition and flame propagation is seriously impeded. In solid fuel beds there is a large reservoir of heat that has what might be termed a flywheel effect against the action of moisture. Indeed, in some cases the moisture's becoming steam and opening up the fuel bed has a compensating beneficial effect. But in a pulverized coal flame it is a direct smothering influence and nothing else.[1] Also, wet coal cannot be pulverized finely and increases grinding cost and grinder maintenance.

Ash, always a dead loss in coal burned in any form, causes still further loss when the coal is burned in pulverized form, by its smothering action on ignition and flame propagation. The ash also adds greatly to furnace upkeep, if its fusion point is too low, by causing slagging. The necessary fusion points for different rates of heat liberation per cubic foot of furnace volume for various types of furnaces are:

	Liberation per Cu.Ft. B.t.u.	Fusion Temperature, Deg. F.
Solid walls	10,000–12,000	2,200–2,500
	12,000–16,000	2,500–2,700
Air cooled walls	12,000–16,000	2,200–2,500
	16,000–22,000	2,500–2,700
Water cooled walls	up to 20,000	2,200
	20,000–30,000	2,200–2,700

These rates of heat liberation are averages for the entire furnace volume. They are for furnaces not equipped with water screens or cooled zones.

Sulphur, usually regarded as a scapegoat, is really beneficial in pulverized-coal boiler installations, particularly when in vegetable form, as it aids quick ignition and flame propagation. The exceptions to this are where economizers or air preheaters are used, to which it is harmful, and where the coal is weathered for a long time and the sulphur, if pyritic, changes to inert sulphate. However, in the latter case it is too small in quantity to be important.

CONCLUSION

Summing up the foregoing, which has been the result of many tests and observations of both boiler and industrial installations, the preferable coal for installations designated for pulverized bituminous coal may be characterized as follows:

Structure—As friable and soft as can be obtained with other specifications.

Burning Characteristic—Flashy, fast flame propagation.

Volatile Content—From 20 to 27 per cent.

Ash—Not over 8 per cent fusion temperature as previously indicated.

Heat value—Not less than 14,000 B.t.u. per pound.

Moisture—Not over 3 per cent.

And, of course, the coal should be clean.

A coal of this character is an extremely flexible one in pulverized coal burning. Good results can be secured over a wide range of fineness of grinding—its structure being such, however, that with pulverizers in even fair shape fineness is obtained—and it adapts itself to a wider range of flame air and velocity adjustments than other coals. With it the best adjustment of all factors for highest operating efficiency can be made without compromise.

But this does not mean that this coal in itself will produce topmost economies, generally speaking, in every pulverized coal furnace in which it is used. The design of each detail of the entire plant has its effect on that. Indeed, problems of adjustment come up and sometimes minor changes are necessary to get the best results from a coal of this type, or even to improve performance, in an installation where another type of coal has been used.

[1] Notwithstanding this, there are a number of successful installations employing coal running high in surface moisture, but the designs have been adapted to meet these conditions.—EDITOR.

DEEP-WELL PUMP TEST TOWER PROVIDES 135-FT. HEAD

AS AN ADDITION to its hydraulic laboratory facilities, the Byron Jackson Pump Company has put into operation a deep-well pump testing tower. This is probably the only testing tower of its kind in the world. It is 96 ft. high and stands over a pit 50 ft. deep. It has five platforms, or testing stations, as shown in the illustration, the highest being 87 ft. above the ground. The tower is equipped with all the modern testing instruments for checking the characteristics and investigating the actions of pumps installed in wells up to 135 ft. deep.

When erecting the deep-well tower, the company had in mind that in a large measure the tower would have sufficient capacity to make full-load tests on a majority of its deep-well pumps. The total over-all length of the average deep-well setting falls within the height limit and pit depth of the tower. There are wells, however, four or five times this depth, but they are the exception. The field of deep-well pumps is increasing, and the total over-all length of certain settings has brought up problems in conjunction with these long columns, the solution of which is simplified by observations that this tower enables the engineers to make.

It is well known that there is a position in which the impellers should rotate, with respect to the water passages in the bowl, to obtain the best performance in the field. A sufficient length of column can be installed in the tower to enable observers to determine exactly the elongation in the rotating and the stationary parts. By these observations the relative elongation can be determined in a setting where the bowls may be 500 ft. or more below ground.

Deep-well pump test tower is 96 ft. high

The tower stands over a concrete pit 6 ft. in diameter and 50 ft. deep. An auxiliary rectangular concrete tank, the top of which is flush with the ground surface, connects to the pit. The capacity of the two is approximately 25,000 gal. The uppermost working platform upon which a motor head may be located is 96 ft. from the surface of the ground, with intermediate platforms for shorter settings. A five-ton electric winch at the top of the tower has a control at each platform and at the ground surface.

Total weight-carrying capacity of the tower is ten tons. However, in case of necessity the pump column can be clamped just above ground and jacks used to reduce the suspended weight and keep it within the capacity of the tower.

Water measurements may be taken with a Venturi meter at the platform where

the pump head is located or by using a drop pipe down to a meter on the surface of the ground. In addition to elongation notations, where required, observations may be made to determine strainer losses, together with hydraulic losses in the column and through the head, if necessary. The tower is wired for 220- and 440-volt circuits. Pumps with motors up to 100-hp. capacity can be tested on the 220-volt circuit, and up to 200-hp. on the 440-volt circuit.

This company also has extensive laboratory facilities for studying the performance of various types of pumps. Also, it co-operates with the University of California, which has the best hydraulic laboratory on the Pacific Coast. In some cases the company's engineers conduct research work at the university, and at other times the university professors and students do work in the company's laboratory and plant.

Recently A. J. Stepanoff of the company's engineering staff experimented on centrifugal pumps at the university. This work consisted of measurements of leakage losses through wearing rings of various designs, with width and clearances at different speeds. The wearing rings tested included plain, labyrinth, stepped, and rings with spiral and circular grooves. Clearances varied from 0.008 to 0.04 in., and the speed ranged from 1,000 to 3,000 r.p.m. in four steps. Mechanical losses, including disk, stuffing box, and bearing friction, were determined for the different speeds. Axial thrust for the different speeds throughout the head-capacity range of the pump was also measured.

▼ ▼ ▼

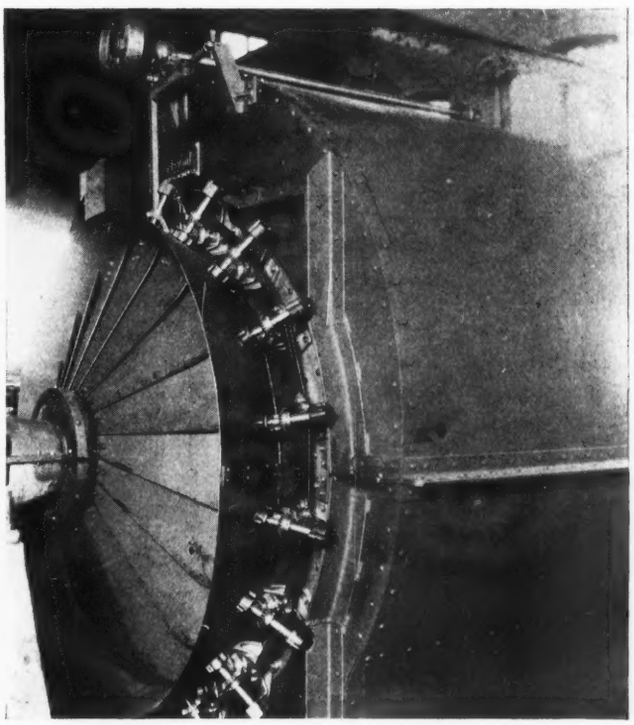
Machine Drawings Sent by Transatlantic Radio

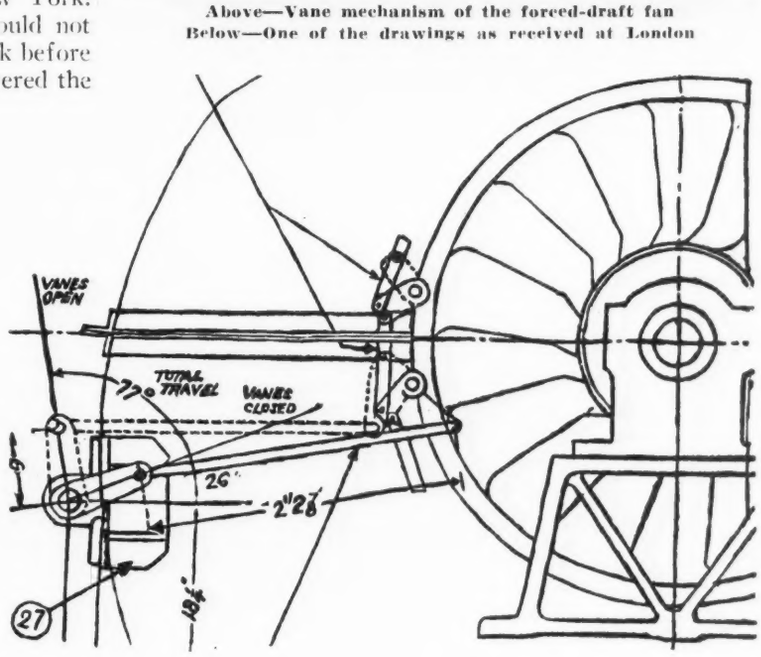
By G. C. Derry

THE B. F. Sturtevant Company, of Hyde Park, Boston, Mass., has made arrangements with Howden-Ljungstrom Company, London, England, whereby the latter is to build certain of the Sturtevant special lines, including vane-controlled fans, for the British Empire. General information has been supplied to the London firm, but it became necessary for them to have specific information on one of the types at once. There was insufficient time to send it by mail, and it was decided to try the R.C.A. photoradio service, believing that the radio pictures would be sufficiently clear for the purpose.

The data wanted involved certain details of the vane mechanism for forced-draft fans of the type here shown. Photographs were required in order to best suit the photoradio process, and since blueprints are not entirely suitable for photographing, the Sturtevant company arranged to loan the originals of the drawings for this purpose. The drawings were taken from the Sturtevant works shortly after noon by the Boston representative of R.C.A. Communications, Inc., for transmission to New York. At that time, even special delivery air mail would not have insured delivery of the package in New York before early the following morning. A messenger delivered the package to the New York airplane at the Boston airport, and upon arrival at Newark another messenger met the plane and delivered the package to the New York office of the Radio Corporation. This was in the early evening. Photographs were made and sent over the New-York-London photoradio circuit. At the same time, a radiogram was sent to identify special items in the pictures. All question regarding legibility of the pictures at the receiving end was dispelled when early the following day more radiograms were exchanged dealing with matters concerning the pictures transmitted.

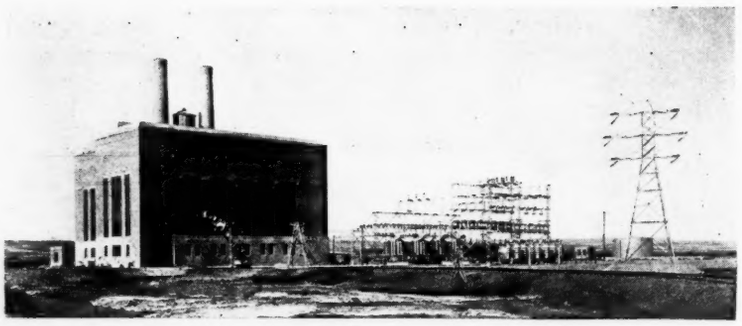
In all, five pictures were sent; one is here reproduced from the photoradio prints as received at London. So far as we are able to determine, this is the first engineering information of this character to be transmitted by photoradio.





Above—Vane mechanism of the forced-draft fan
Below—One of the drawings as received at London

Another Texas Power Plant Turns to



NATURAL GAS

This new 43,750-kw. plant of the El Paso Electric Company was placed in operation eight months after construction started

BY R. C. STEWART
Stone & Webster Engineering Corp.

THE El Paso Electric Company recently found itself faced with the problem of providing capacity to meet a growing load. The limit of the basic facilities at the existing plant location was approaching, and a decision had to be made whether to spend more money in the old location or to select a new site and build a new plant, with larger initial capital expenditure.

Decision was reached in favor of the new plant. Work was started at once, and in less than eight months from the time the first pile was driven, power from the first turbine-generator of a 43,750 kw. plant was on the line. This well-regulated speed was made possible by co-ordinating the plans of design and construction so that each worked in full co-operation with the other.

The site selected is strategically situated to obtain a maximum supply of condensing and cooling water in a country where water is at a premium. It is on the Rio Grande about four miles upstream from the present station, just above the pass where the river breaks through and from which the city takes its name. Here the main drainage canal of the irrigation district joins the river, and it is expected that water will be available for an ultimate development of a plant of 180,000-kw. capacity, providing the supply is supplemented with a recirculating condenser-water cooling system. Although the location of the power house is favorable from the standpoint of water, the ground is underlain by deep strata of fine river silt and sand, so that 1,100 piles had to be driven to insure a firm foundation.

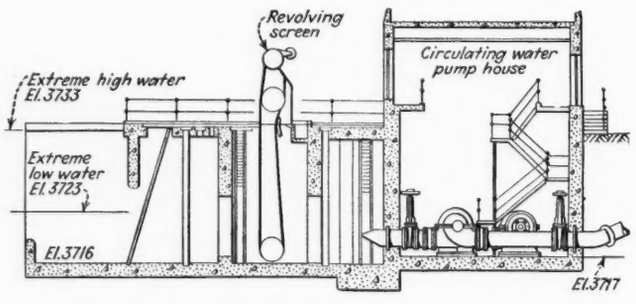
A pipe line 200 miles long had recently been run across the desert from New Mexico to bring gas into the district, so the two Stirling boilers were equipped for it. Combination burners permit of the use of fuel oil.

The boilers each have a heating surface of 15,253 sq.ft., and are equipped with complete water-cooled surface walls, a tubular air heater, and a superheater. They generate steam at 450 lb. per square inch and 750 deg. F. final temperature.

Only one new turbine-generator, of 25,000-kw. rating, was bought, as one of 18,750-kw. rating was moved from the old plant and installed after the new one was in service. This gave an installed capacity of 43,750 kw. Both generators have direct-connected exciters, and exhaust to surface condensers of 24,700 sq.ft. and 25,000 sq.ft., respectively.

The condenser cooling water is taken directly from the drainage canal and discharged into the river downstream. When water from the drainage canal is insufficient the river flow will enter the canal to help out. At times even the combined supply may be inadequate. Then the river will be pumped so low that the discharge water will flow "upstream," and both the fresh and the used water will enter the canal to be pumped into the condensing system. The supply of water to each condenser is safeguarded by two pumps at the intake for each condenser supply pipe. Much débris floats down the river when it is high. This is excluded from the condensing water by traveling screens.

The transformers and electrical bay are located between the boiler and turbine rooms—a somewhat unusual arrangement



A house-service turbine-generator set of 2,000-kw. capacity is arranged so that it is capable of taking full load in twenty seconds. It is operated by push button from the switchboard.

The station auxiliaries are arranged for motor drive, except one each of the boiler-feed and fuel-oil pumps, which are provided with turbine drives, and the spare exciter set, which has both motor and turbine drives.

The feed-water heating system is of conventional three-stage type, including one high-pressure surface-type heater, one deaërating heater, and one low-pressure surface-type heater. A two-unit single-effect evaporator supplies boiler feed make-up. Extraction points are provided on the main turbines to furnish steam supply for the various heaters and evaporator.

The boiler furnaces are each equipped with ten combination natural-gas and fuel-oil burners. Forced draft for each boiler is supplied by one fan equipped with movable inlet vanes for volume control and driven by a constant-speed induction motor. The induced draft for each boiler is provided by one fan with movable inlet vane control and directly connected to two constant-speed induction motors, the two motors being of different capacities and speeds for operation under different load conditions.

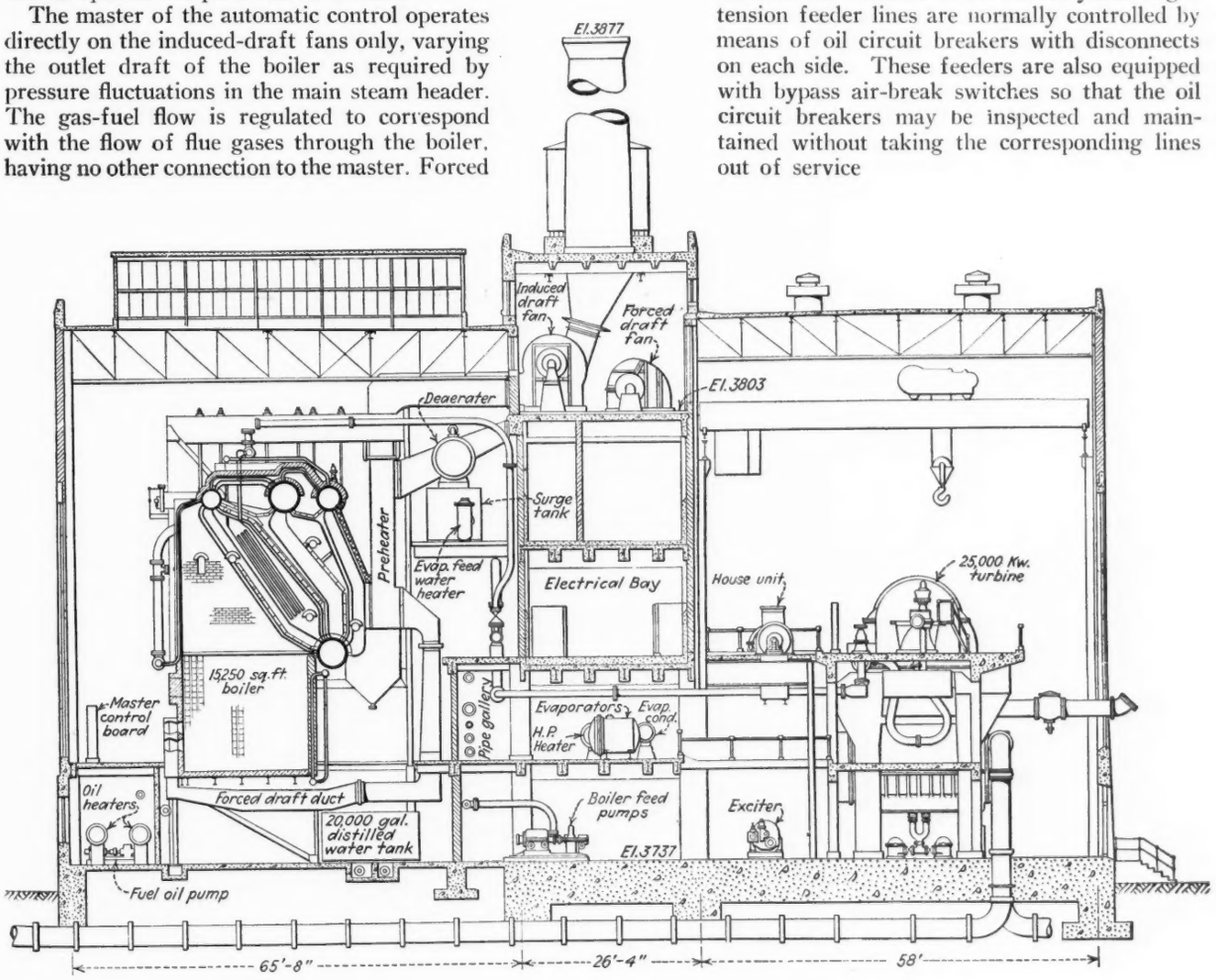
The supply of gas fuel, of air for combustion, and the uptake draft are regulated by a combustion control system consisting essentially of a number of push-button units to which are added an automatic system to operate the push-button circuits.

The master of the automatic control operates directly on the induced-draft fans only, varying the outlet draft of the boiler as required by pressure fluctuations in the main steam header. The gas-fuel flow is regulated to correspond with the flow of flue gases through the boiler, having no other connection to the master. Forced draft is automatically regulated to hold balanced pressure in the boiler furnace. A mechanical device is provided to cut off all gas fuel to burners when the flow of flue gas through the boiler is less than a set amount or when the pressure in the fuel line is below a safe low limit.

This somewhat unusual arrangement of control equipment was considered necessary because of the properties of gas fuel, which make possible its partial combustion, due to deficiency in air supply, without the condition being made evident to the operators by excessive smoking; also to the fact that when once mixed with combustion air the mixture is permanent, instead of separating, as air mixtures of other fuels will do.

The main units, of 18,750 and 25,000-kw. capacity, respectively, at 80 per cent power factor, generate at 13,800 volts, 3 phases, 60 cycles. The house unit, of 2,000-kw. capacity, at 80 per cent power factor generates at 2,300 volts, and is connected to the auxiliary system, which is normally fed from the 13,800-volt bus through a 3-phase transformer of 2,500-kva. capacity. Auxiliary motors of over 50 hp. are fed from the 2,300-volt circuits. Smaller motors are fed from the 460-volt lines, which are energized by two 300-kva., 3-phase transformers fed from the 2,300-volt lines. Full voltage motor starting is used throughout. Station lighting is supplied from two 100-kva. single-phase transformers.

For transmission purposes the 13,800-volt energy from the generators is stepped up to 66,000 volts through a bank of three 12,500-kva. single-phase power transformers located in the switch yard. High-tension feeder lines are normally controlled by means of oil circuit breakers with disconnects on each side. These feeders are also equipped with bypass air-break switches so that the oil circuit breakers may be inspected and maintained without taking the corresponding lines out of service



. . . RIGHT OUT OF THE PLANT . . .

Gas Produced in an Electric Steam Generator

DECOMPOSITION of water by electrolysis where alternating current is used is not commonly considered possible. An explosion of a minor nature but of sufficient force to cause apprehension as to the possibility of damage being done, led to an interesting experiment being made by the research department of a large industrial company in connection with an electric steam generator. Fig. 1 shows the construction of the boiler. The water level in the lower half of the shell is shown by the lower gage glass. The usual form of feed pump automatically controlled by a float is employed. A circulating pump takes water from the lower half and discharges it into a basket supported in the upper part of the boiler.

The basket is cylindrical, is open at the top, and has a double bottom. Water discharged from the circulating pump is conveyed through the outer shell to the space between the two bottoms of the basket. Perforations near the outer circumference of the top bottom plate permit the water to ascend and fill the basket to a suitable level. After contact with the electrodes the water goes to the center and downward through the bottom of the basket, where it is conveyed to the opposite side of the outer shell and by a return bend to the bottom of the boiler. The water level is maintained by adjusting the control valve on the circulating discharge line. A gage glass in communication at its lower end with the water within the basket shows the lever in this part. The water level carried is sufficient to cover four or more inches of the three electrodes projecting through the top. Alternating current at 2,300 volts is used, and the full-load current is 396 amp. The safety valve is set at 100 pounds.

Apparatus used to check up on the amount of hydrogen gas liberated is shown in Fig. 2. Steam was taken from the highest point in the boiler, and passed through a condenser made of $1\frac{1}{4}$-in. pipe inclosing a $\frac{3}{8}$-in. pipe. The small pipe was connected to the steam line end and to an inverted burette. The burette and $\frac{3}{8}$-in. pipe were filled with water. When the apparatus was placed in operation the gases from the stream rose to the top of the inverted burette and displaced the water. Pressure of the confined gas forced the water up through a rubber hose to a second burette open to the atmosphere.

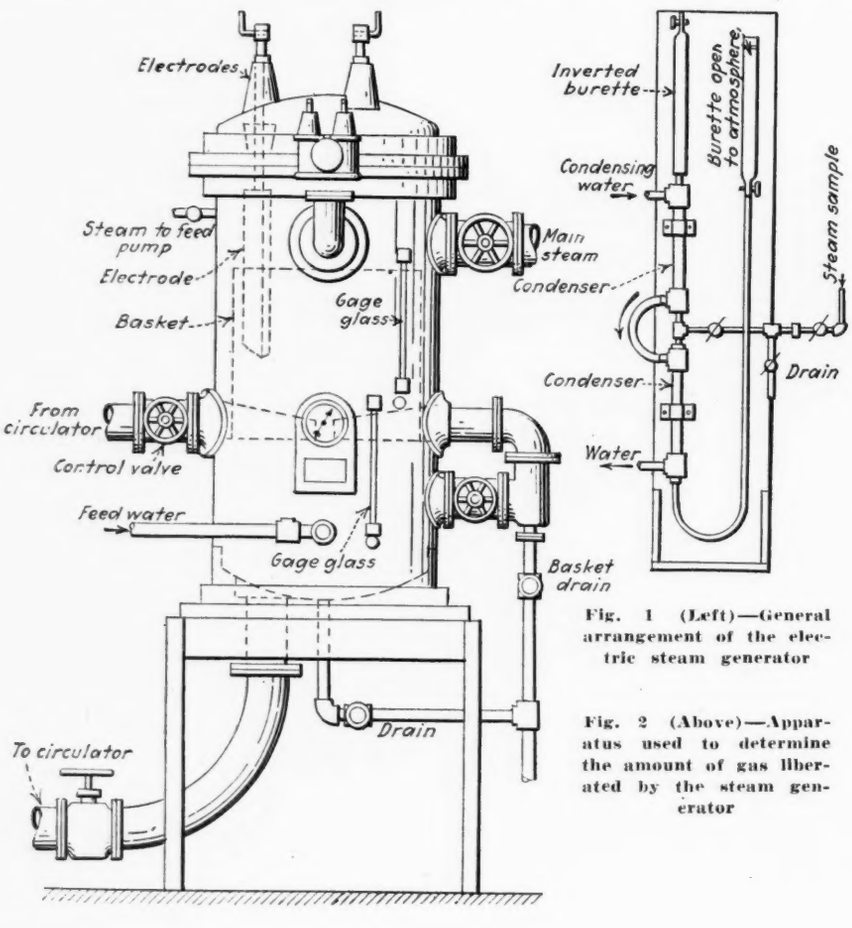


Fig. 1 (Left)—General arrangement of the electric steam generator

Fig. 2 (Above)—Apparatus used to determine the amount of gas liberated by the steam generator

The report of the research department was that an explosive gas, hydrogen, was being generated under all conditions but was not of sufficient magnitude to be dangerous. It was observed that the amount of gas varied inversely in volume as the amount of steam used and varied also with the density of the water.

Feed water is sufficiently pure to be used in place of distilled water for batteries. Scale-forming substances are like those usually found in river water and are about 90 parts per million, being mostly calcium carbonate, magnesium hydrate, silica, and iron oxide. Scale forms rapidly, and, from the large proportion of iron oxide in it, it would appear that the oxygen released when the water is decomposed unites with the iron of the electrodes, forming iron oxide, and liberates the hydrogen. Notwithstanding this, the boiler has a high efficiency, and where cheap power is available is economical for generating steam.

Trail, B. C. ARIEL W. MILLER.

Should the Superheat Be Omitted When Determining the Boiler Rating?

THERE is one problem I should like to see discussed in *Power:* The manner of calculating the rating at which a boiler and superheater are being operated. For example:

Boiler, sq.ft. heating surface	6,000
Feed water, deg. F.	210
Steam pressure, lb. gage	160
Superheat, deg. F.	175
Load, lb. steam per hour	40,000

I find the rating by using the total heat imparted to the steam, in this case:

$$\text{Rating} = \frac{40{,}000 \times (1{,}292 - 178)}{6{,}000 \times 3.45 \times 970.4} = 222 \text{ per cent.}$$

It would seem more logical to neglect the heat added by the superheater and to consider the work done by the boiler alone:

$$\text{Rating} = \frac{40{,}000 \times (1{,}196 - 178)}{6{,}000 \times 3.45 \times 970.4} = 202 \text{ per cent.}$$

The superheating surface has never been given a "rating." It can be rated only on the basis of B.t.u. per square foot per hour. It is wrong in any sense, however, to add the work done by the superheater when the boiler surface is used as a divisor. The term "rating of boiler, superheater, and economizer," for instance, illustrates the absurd lengths to which an originally simple standard has been stretched.

In some tests I have examined, the perverted use of the standard serves to bring the "rating" up to or over the desired 300 per cent.

After all, this is only another plea for abandoning the term altogether. JULIUS BOEHMER, JR.

St. Louis, Mo.

Benson Plus Loeffler

AS THE representative of the Loeffler system in the United States permit me to express an opinion on Wilhelm Firing's proposed combination of the system in *Power* for April 15, 1930.

Mr. Firing calls the booster pump a disadvantage, but forgets that it procures advantages which were heretofore unknown to the art of steam generating. In suppressing that circulating pump he introduces an injector and an extra feed pump, and a pressure of 3,200 lb. to keep them busy. Let the Benson man thank Mr. Firing for what he may do for him and let me speak *"pro domo."*

Professor Loeffler's design, I think, gives highest desirable pressure and superheat with the fewest undesirable features in construction, operation, maintenance, etc. Mr. Firing can inspect such boilers at Vitkovice, and it may help him to realize that Dr. Loeffler's first aim was to keep the water out of the fire and to make the superheater independent of the withdrawal of steam in the line. The booster pump seems to do that, as nothing else, in a reliable way, which, incidentally, points to greatest security of operation and highest availability. As that pump moves, so moves the steam. Without questioning whether an injector could be made to function as flexibly, as controllably, and as reliably as a turbine-driven centrifugal, I point to the auxiliary boiler feed pump for highest pressure, which Mr. Firing proposes to add, as decidedly undesirable.

Mr. Firing wishes to "spare the superheater" from radiant heat in protecting it with Benson water. That, it seems to me, is exactly the opposite of Dr. Loeffler's aim and seems a superfluous effort. Besides, the Benson tubes would surely require much greater thickness of wall than do our present superheater tubes.

The centrifugal pump which Mr. Firing so dislikes uses about 2 per cent of the boiler energy at full load. Let us overlook the fact that, after all, some of the energy consumed by that booster pump goes back in form of heat of compression and friction. We must still admit that, at lesser load, the surplus of steam of the Benson section would have to be eliminated for fear of securing excessive superheat, in such case, of the steam coming from the Loeffler drum. I can see no gain in the use of that injector, at best. How would Mr. Firing safeguard the Loeffler superheater, when such a combined system is started, before the injector has the highest pressure steam available? Probably by further encumbrance.

His proposed change would add cost and expense of plant and operation, would make it more difficult to operate and regulate, and reduce its safety. And wherein would we gain? I believe Mr. Firing's combination would be an unnecessary and impractical complication.

New York City. ARTHUR J. HERSCHMANN.

Coal Pulverizing Cost Reduced By Centrifugal Lubrication

WITH reference to the article in the May 20 number entitled "Coal Pulverizing Cost Reduced by Centrifugal Lubrication," it would seem that the cost of lubrication for the pulverizer was still high. In contrast with the figures given for the Gould Street station of 0.3 to 0.4 lb. of grease per ton of coal milled, the Narrows power plant of Virginian Railway Company, at Narrows, Va., has milled 391,262 tons of coal and used a total of 10,013 lb. of grease, or 0.025 lb. per ton. The grease used in the plant has been kept separate for the different equipment, but the separate figures are not available. The 10,013 lb. of grease has not only lubricated the six-roll pulverizers, but also all coal-handling equipment (crusher, feeder, skip hoist, flight conveyor, screw conveyor, and feeder screws); also, feed pump bearings, water-screen elevators, and numerous other places in a power plant of 50,000-kw. capacity.

During the period when the 391,262 tons was being milled no rolls had to be removed because of sticking and becoming flat and no wearing rings were renewed.

Grease costing 11c. per pound is used. When the grease does not feed to a roll, a small quantity of filtered oil is poured into the grease cavity.

It seems to me that a little attention to the seal rings and to the quality of the grease used would have saved the trouble of changing the lubricating system at the Gould Street plant. The cost of oil after the change is 11 per cent of the cost of grease before the change. Using the figures of 0.35 lb. per ton for the Gould Street station, the amount of grease for everything at the Narrows plant is only 7.3 per cent of that for milling alone at the Gould Street station.

CLINE BOWSER,
General Foreman,
Narrows, Va. Virginian Railway Power Plant.

Personal Records and Reports

OFTEN an engineer from outside the plant is employed in a consulting or advisory capacity. Likewise, inspectors and machinery insurance agencies are employed.

The length of their stay depends on the nature of their reports, which, in turn, is governed by the results that they produce. In other words, they have to show a profit in the savings made, over their retaining fee.

It is probably fortunate for most plant engineers that their retention does not depend on their reports to the plant manager. If it did, it would be just too bad for some of us.

The plant engineer is in a consulting capacity with a steady job, and knows the plant and equipment better than anyone else, that is, providing he does not become plant blind from looking at the same thing day in and day out. Therefore, he is in a better position to turn in reports of merit than anyone else.

The plant engineer has something to sell: Personal assets that make up his ability to handle the position.

No salesman would attempt to sell goods to a customer without first making him acquainted with the product. He will have the history of the goods, and if they are of a productive nature he will have data and performance curves to convince the customer that he should buy his product rather than that of his competitor.

The plant engineer, in most cases, expects his customer, the manager, to accept his wares at their face value. He is attempting to sell his services on the open market, where competition is keen, without any data or performance curves showing that he should be preferred to a cheaper agency aiming to get in at any price.

Executives of today are busy men and have too much on their minds to remember the accomplishment of each man in the plant. This tends toward standardization of man power, with no marks of distinction between the man who goes out of his way in the performance of service and the man who lets well enough alone. Meaning, a man will often see something in another department, without interfering with the affairs of someone else, that, when corrected, will mean a saving for the company. This standardization of man power brings an evil too often overlooked; too many good men leave their company each year because they feel that they are not getting proper compensation for their services.

The first thing a manager will say when asked for a raise in salary is, "What makes you feel that you are worth more money?" The applicant will usually be stumped right there. After a little thinking nothing comes to his mind, although he may have several worthwhile items of accomplishment that should "sell" him. In his confusion, instead of mentioning them, he will probably reply, "Well, I am keeping the plant running; the equipment is in good condition . . . " Whereupon, most managers will put an end to the conversation with, "Isn't that what you are drawing your check for?"

Compare the foregoing conversation between the manager and applicant for a raise in salary with this one: "What makes you feel you should have a raise?" The applicant replies: "If you can spare a few moments of your time, I have a condensed record of accomplishments that I should like to show you.

"Our steam costs are so and so many dollars less this year than last, which has been brought about without the expenditure of much money.

"We have made economies in the boiler house in several ways, such as saving on the waste of hot water throughout the plant, enabling us to maintain a higher feed-water temperature. We have also educated the personnel of our boiler house to know more than merely how to shovel coal. They now know what a B.t.u. is; also, what is meant by evaporation, boiler rating, the advantage of heating the feed water, and that of steady even firing. All of this has effected economies.

"Another large saving was effected by changing to the type of fuel best adapted to burning in our furnace. This we did after exhaustive tests."

Where an engineer can go before a plant manager with facts, written in an understandable language—which to the executive is dollars and cents—he is likely to get the increase in salary asked for if it is in reason.

The engineer may know that he is doing good work, and yet his manager may look upon him as an ordinary engineer, just keeping water in the boilers and coal under them, if he is not well informed otherwise.

For this reason the engineer should be interested in keeping the management well informed regarding progress in the power plant. The manager should know that the engineer is generating steam and power economically; that the equipment is being well maintained.

Cost records and periodic reports is the answer. Most of this information can be obtained from the daily log, excerpts from which, together with notes of explanation as to how certain economies or improvements were made, is the correct procedure in keeping the manager informed. These reports are also educational to the engineer. Once he begins to look for valuable items to incorporate in his reports, they will start cropping up from many sources.

Reports may be made weekly, monthly, or annually. A daily report may be made of certain operations being watched closely for special information.

Regardless of the frequency of the reports, a yearly summary setting forth the major accomplishments should be rendered

A man is worth just as much to his company as he will be to another one. Therefore, one contemplating a change should take inventory of himself and be fair when rendering judgment. Here a personal record of effort and achievement will be invaluable in deciding on whether to dig in anew or to look for another connection.

MARIN PHILIPS.

Niagara Falls, N. Y.

Turbine Vibration Caused by Defective Seal

A TURBINE was found to vibrate seriously while running. The cause of the vibration was finally traced to a defective high-pressure shaft seal. It was found that steam was leaking between the shaft and the rotating part of the seal mounted on it. This caused unequal heating of the turbine shaft, which, in turn, caused the rotor to vibrate. Before the fault was corrected, the seal rubbed and was damaged to such an extent that it had to be renewed.

To prevent a repetition of this trouble, grooves were cut on the inner circumference of the new seal member so that in the event of steam leaking it would be distributed around the shaft and no uneven heating could occur to distort the shaft and cause vibration.

London, England. W. E. WARNER.

Economics of Combined Hydro and Steam Power Systems

By N. E. FUNK
Vice-President in Charge of Engineering
Philadelphia Electric Company

These excerpts from a paper presented at the recent World Power Conference in Berlin show clearly that there is no standard method of dividing the load between steam- and hydro-electric stations in systems combining these two types of plants. The allocation of peak and base loads varies with the nature of the water powers, stream flow, and amount of storage available. Under certain conditions the hydro stations should carry the peak during periods of low water and the base load during high-flow periods.

THE title of this paper indicates that it is confined to systems jointly supplied by hydro-electric and steam-electric power stations. However, practically all of the economic variables and advantages that apply to either system alone also apply to a combined system, while some of the disadvantages of each individual system are eliminated.

Steam-electric stations are usually adjacent to the load they supply, while the locations of hydro-electric stations are determined by the power sites to be developed and are nearly always at some distance from the load. Transmission problems are therefore more frequently met in hydro-electric than in steam-electric developments. Hydro-electric developments, including long-distance transmission only, are here considered.

A hydro-electric system serving important load centers should have relay generating stations that can immediately supply the most important part of the load in event of transmission-line failures. This entails added investment for duplication of capacity which is absent in properly proportioned combined systems, since the steam-electric stations are always available to carry the important loads.

Usually, the operating and investment cost of a hydro-electric system per unit of energy produced is more adversely affected by a low system load factor (due to the high investment cost per unit of firm capacity) than is the case for the same low system load factor of a combined system, which has a lower investment per unit of power supplied.

With limited stream flow, a material increase in the load factor of a given system with growth may entail the development of additional hydro-electric stations to supply the added energy without adding a corresponding firm capacity to the system. This situation does not exist in a combined system, since there is no fundamental limitation to the load factor of a steam system comparable to the stream-flow limitation of a hydro system.

Continued increase in the size of steam-electric generating units has brought increased periods of time required for starting cold, varying from one to three hours, depending upon the size of the unit. This necessitates continually operating more capacity than would otherwise be necessary to be prepared against a unit's developing trouble that requires its immediate removal from service. The hydro-electric power station is an ideal supplement to these large steam-electric units, because the starting time of the hydraulic turbines is so short, permitting of a reduction in the amount of steam-electric generating capacity that must be kept in operation for service insurance. This reduces the operating cost of the steam stations and therefore that of the combined system.

The operation of peak steam-electric stations is very expensive, without any compensating low costs for base-load operation. A hydro-electric station, on the other hand, may be used as a peak load carrier at comparatively low operating expense during low stream flows, and at very low costs when used for base-load operation during high flow periods. This advantage of the hydro-electric station accrues only in a system of sufficient size to permit of the plant's being changed from base load to peak load as necessitated by available stream flow, and if the remaining source of supply has no load-factor limitation, as exemplified by a steam-electric station.

Operation of a Combined System

The operation of a combined system varies with the characteristics of the stream supplying the hydro-electric power. There are some developments, such as those at Niagara, which must utilize a constant flow and hence are operated at constant loads. Any steam-electric power station operating in conjunction with power from such sources must operate on a load curve above the capacity supplied by the hydro-electric stations. These steam-electric plants will therefore have an operating load factor substantially lower than that of the system.

Where a large amount of storage is available, the hydro plant may be developed considerably above the capacity corresponding to minimum stream flow, and may be utilized for peak load, regulating, or emergency purposes, with the steam-electric plants supplying the high-load-factor base load.

The most difficult operating problems arise in the economic operation of a combined system in which the source of hydro-electric power is a stream having great variations in flow and only enough storage to equalize the flow for short periods of time. A hydro-electric plant on a stream of this type must be operated as a base-load plant during the periods of high stream flow, at which time the steam-electric plants will supply the peak load.

When the stream flow has fallen the capacity of the hydro-electric plant will be seriously reduced if it is operated base-load. If, however, the relative positions on the load of the hydro-electric station and the steam-electric stations are changed—that is, if the steam stations are given the base load and the hydro station the peak load—the firm capacity value of the hydro-electric station may be preserved without any reduction in its energy output.

From Among Readers' Problems

Conducted by
L. H. MORRISON

REMOVING SCALE FROM JACKET OF DIESEL ENGINE—*What chemicals can be used in cleaning scale out of a Diesel engine's cylinder heads and jackets?* H. S. L.

Muriatic acid (hydrochloric) is the chemical most frequently employed. It is suggested that you use a mixture of 25 per cent strength, namely, one gallon of muriatic acid and three gallons of water. Pour this into the jacket and allow it to remain for one or two hours, until fuming of the chemical ceases. Allow the mixture to run out and then flush out the jacket with water. If the scale is very hard and thick, it may be necessary to allow the mixture to remain in the jacket as long as five or six hours. Although there is little danger of the acid's affecting the iron to any extent, to be on the safe side the acid mixture should not be allowed to remain in the jacket longer than necessary to soften the scale.

The permanent solution is to use distilled water in the cooling system and cool this water in a closed coil by raw water.

ELEVEN POUNDS VACUUM—*When a vacuum gage, connected with the condenser of an engine, which operates condensing, indicates "11 lb. vacuum," what does that signify with respect to development of power and operation of an engine?* G. H. F.

A vacuum gage shows pressure below the pressure of the atmosphere. At sea level the pressure of the atmosphere is 14.7 lb. per square inch absolute, or 14.7 lb. pressure above a perfect vacuum. When the gage indicates 11 lb. vacuum the back pressure in the condenser or exhaust pipe with which the gage is connected is 14.7 — 11 = 3.7 lb. per square inch absolute.

In a non-condensing engine the exhaust takes place against the pressure of the atmosphere, and the back pressure usually is one or more pounds pressure per square inch greater than atmospheric pressure, on account of frictional resistances to the free escape of the exhaust. When the engine exhausts against 11 lb. vacuum and the pressure of the atmosphere is 14.7 lb. per square inch, the back pressure on the exhaust is only 3.7 lb. per square inch absolute. As one pound of forward pressure acting on the piston of an engine is required to overcome one pound of back pressure, 11 lb. vacuum, shown by the vacuum gage connected with a condenser, signifies that the effectiveness of the forward pressure has been increased at least 11 lb. per square inch from operating the engine condensing in place of non-condensing.

The reduction of back pressure, commonly referred to as the degree of vacuum, usually is expressed as inches of mercury column pressure less than the pressure of the atmosphere. As one inch of mercury column exerts a pressure of 0.491 lb. per square inch, 11 lb. vacuum is equivalent to 11 ÷ 0.491 = 22.4 in. of vacuum, referred to a mercury vacuum gage. Under ordinary conditions at least 26 in. vacuum should be obtained, and an indication of only 11 lb., or 22.4 in. vacuum, may be due to air leakage, inefficiency of the condenser, too little or too high a temperature of condenser cooling water, or faulty operation of the vacuum pump.

A Question for Our Readers

I AM operating a 1,250-kva waterwheel generator and a 1,000-kva. steam turbine-generator in parallel and they are synchronized with a synchroscope. If the synchroscope were out of order, could the incoming machine, without excitation, be brought up to synchronous speed and connected to the busbars; and when the machine is operating as an induction generator can the exciter switch be closed and have the generator pull into step? I had in mind this emergency method of paralleling in case the synchroscope failed. I shall appreciate any advice POWER *readers give me.* D.O.J.

Suitable answers from readers will be paid for any published in the Aug. 12 number

SINGLE AND DOUBLE SHEAR OF RIVETS—*What is meant by boiler rivets being in single shear or double shear?* R. N. B.

A rivet is subjected to single shear when it extends through two adjacent plates that are pushed or pulled one over the other, tending to force part of the body of the rivet over the adjacent part, like the action of a pair of shears, and produce cleavage at a single cross-section of the rivet. The rivets of lap seams are subjected to shear at a single cross-section, or, as commonly stated, they are in single shear.

A rivet is subjected to double shear when it extends through three plates and the push or pull of the middle plate is opposite to the push or pull of the outside plates, tending to produce cleavage of the rivet on each side of the middle plate.

In a butt and double-strap joint, where the outside strap is narrower than the inside strap, the inner rows of rivets that pass through the main plate and both of the straps are subjected to double shear, and the rivets of the outer rows, which pass through the main plate only, and the inside strap are subjected to single shear.

GRAVITY RETURN FOR 1-IN. PIPE COILS—*Our laundry drying-room coils, made of 1-in. pipe with ¾-in. supply, are located about 5 ft. above the boiler, which supplies the coils with steam at 85 lb. pressure. At present the coils discharge to the sewer. How can they be made to return the condensate to the boiler by gravity?* G.A.M.

For a gravity return, the pressure at the point where the condensate leaves a coil, together with the head of water in the return pipe, must be sufficient to overcome the friction of the return pipe and fittings and the pressure in the boiler. With the coils 5 ft. above the boiler, and allowing the boiler-water level to be 1 ft. below the top of the boiler, the head of water in the return pipe would amount to about 6 × 0.433 = 2.59 lb. per square inch. Hence to obtain a return by gravity, without allowing for loss of pressure from pipe friction, the pressure at the discharge end of the coils would have to be 85 — 2.59 = 82.5 lb. per square inch.

To maintain the necessary pressure at the discharge end of a 1-in. pipe coil less than 75 ft. long and constructed with headers, the diameter of the live-steam inlet in inches should be made equal to about the square root of 1/34 of the number of feet of 1-in. pipe in the coils. A ¾-in. connection would be suitable for a pipe coil containing only about 19 ft. of 1-in. pipe.

PREVIOUS QUESTION

Discussed by Readers

THE QUESTION

THE three rings of a three-phase, wound-rotor, 200-hp., 440-volt motor are short circuited by a drum switch. With poor contact at one ring how will the stator current be affected at full load? What percentage of normal current will flow in the leads connected to the brushes making good contact. How much will the motor's capacity be reduced if the brushes make good contact on two slip rings only? R.L.H.

WITH a poor connection at one of the short-circuiting segments of the drum controller, or at one of the collector-ring brushes of a wound-rotor induction motor, there will be considerable arcing, and the stator current will fluctuate up to 40 per cent above normal full-load value.

With an open circuit in one of the rotor phases, the stator current will increase to approximately double the normal value, while the rotor current may increase to as high as 600 per cent of the normal value, depending on the amount of the load at the time of the test. The motor will rotate at approximately one half of normal speed, and since the horsepower rating and speed vary in direct proportion, the rating will be one half of normal.

A motor will not operate long under these conditions, as it can readily be seen that the temperature rise in the stator windings will correspond to normal load, and in the rotor winding will be equivalent to from four to six times normal load. The following are results of some recent tests made on wound-rotor motors:

In the first test the motor had a rating of 20 hp., 550 volts, 3 phases, 60 cycles. The full-load stator current was 19 amp. The machine was wound for ten poles, which on 60 cycles corresponded to a synchronous speed of 720 r.p.m. At the time of the test the motor was driving a load that required 15 amp. per phase in the stator and in the rotor, and the speed was 716 r.p.m. When one phase of the rotor was opened the stator current in the three phases increased to 25 amp., or 66.6 per cent. In the rotor the current increased to 85 amp. in the two closed phases, or 466.6 per cent. Under these conditions the speed was 358 r.p.m., one-half normal.

Another test was made on a 150-hp., 14-pole motor, the synchronous speed of which is 514 r.p.m. and the full load stator current 158 amp. In other respects this motor was the same as the one previously mentioned. At the time the test was made the motor load corresponded to 137.5-amp., 3-phase current in the stator and 70 amp. in the rotor. The speed was 510 r.p.m. With one phase open in the rotor, the stator current increased to 200 amp., or 45 per cent. The rotor current increased to 315 amp., 350 per cent above normal, and the speed dropped to 254 r.p.m.

It will be noticed that there was a considerable difference in the per cent increase in the current of the two motors. This can be accounted for in the change in load on the motors because of the speed reduction.

H. E. STAFFORD, *Electrical Engineer*,
Provincial Paper Company, Ltd.
Port Arthur, Ontario.

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WHEN answering "R.L.H's" question, one is inclined to ask, Why worry about the effects of poor contacts? Repair the fault and you will not have to bother about the effects. There is, however, another side to the question. Within certain limits, poor connections in the rotor circuit have the same effect as starting or operating the motor with unbalanced resistance. Wound-rotor motors are sometimes started by cutting the resistance out one step at a time in alternate phases. When this is done, the rotor resistance is balanced on every third step only.

Unbalancing the resistance in the rotor circuit will throw the currents in the rotor circuits out of balance. There is also a pulsation of the stator current that may be ojectionable, particularly if there are lights on the same circuit. Within reasonable limits this unbalancing does not materially increase the heating of the motor. With a variation of 2 to 1 in the resistances of the rotor circuits the current probably will not be out of balance more than 50 per cent.

In the *Transactions* of the A.I.E.E., 1917, p. 339, A. A. Gazda discusses the performance of wound-rotor polyphase induction motors operating under unbalanced secondary conditions. The author comes to the conclusions:

1. With the proper design of resistor steps it is safe practice to operate polyphase induction motors at full-load torque, with unbalanced secondary resistance. Under these conditions, the power factor will be slightly reduced, but the increased copper loss will be amply compensated for by the better ventilation of the motor at the higher speeds.

2. A limited range of motors which have a low percentage of magnetizing current may be operated under full-load torque at half speed, with single-phase secondary; while practically any motor may be operated under these conditions when driving a variable-torque load.

Tests made by Gazda on a 40-hp. motor to determine the effects of unbalanced resistance in the rotor circuit are given in the accompanying table. It will be seen that even with the rotor resistance out of balance 3 to 1 the equivalent balanced secondary amperes remain fairly constant for the six tests. Experience shows that in any rotating equipment carrying unbalanced load the heating will be approximately proportional to the sum of the squares of the various currents. On this basis it will be safe to operate the motor under any of the conditions given in the table. The amount of insulation on the coils is a factor, and if the insulation is very thick unbalanced currents may cause excessive local heating if the motor is operated near full load. In Gazda's work a large number of tests was made on motors of various sizes and speeds to check the heating in the rotor copper. A fairly uniform heating of the rotor was demonstrated by both thermometers and by resistance readings. The total secondary copper loss was found to run 5 to 10 per cent higher under unbalanced than under balanced conditions.

When one of the phases is open in the rotor it tends to operate at one-half normal speed. Tests made to observe the operation of polyphase motors running with a single-phase secondary showed that under these conditions the starting torque is about 60 per cent of the torque under balanced conditions, the current in the secondary winding being the same in both cases. The no-load magnetizing current is an important factor in this case and must be taken into account. Tests on a 40-hp. motor showed that at no load the primary magnetizing current was approximately twice the amount required under normal balanced conditions, but as the load increased the primary current decreased before it started to increase. R. B. JENKS.
New York City.

OPERATION OF 40-HP., 3-PHASE, 60-CYCLE, 220-VOLT INDUCTION MOTOR WITH DIFFERENT VALUES OF EXTERNAL SECONDARY RESISTANCE

Resistance, Ohms per Leg			Primary Volts			Primary Amperes			Equivalent Balanced Primary Amperes (R.M.S.)	Secondary Amperes			Equivalent Balanced Secondary Amperes (R.M.S.)	Speed, R.P.M.	Pound-Feet Torque	Power Factor
0.81	0.81	0.81	220	218	220	114.8	109.2	110.8	111.8	77.2	76.8	76	76.7	415	242	78.6
0.81	0.81	0.39	220	218	220	117.7	110	114	114	64.4	90.1	79.2	78.6	520	242	77.15
0.39	0.39	0.81	220	218	220	117	110	114	113.8	90.6	62.3	79.5	78.4	600	242	77.5
0.39	0.39	0.39	220	218	220	111.7	104	110	108.7	75.2	75.2	74.8	75.15	660	242	79.7
0.13	0.13	0.39	220	218	220	114	108	112	111.4	90.7	55.4	81.7	77.2	768	242	78.4
0.39	0.39	0.13	220	218	220	114	108	111	111.2	63	92.6	72.4	77.1	723	242	78.2

New Portishead Station in England

Has Features of Unusual Interest

Boilers of 100,000 lb. capacity, equipped with economizers and forced-draft chain grates 24 ft. wide make good record on test carried out under working conditions. The condenser circulating system is designed to function over 52 ft. range of water level

THE city and county of Bristol, England, placed in operation a few months ago the first section of the new Portishead power station,[1] which has an initial capacity of 41,100 kw. in two turbine-generator units. The first of two 50,000-kw. units for which the station building also provides is being installed, and there is space on the site for further extension. Five hundred yards from the River Severn, adjacent to the Portishead Docks and to sidings of the Great Western Railway, the plant has an unlimited water supply, and both rail and water transportation are close at hand.

Certain features of this modern stoker plant, using boilers of 100,000 lb. maximum capacity, are of interest. The boiler plant has shown an efficiency under working conditions of 89 per cent. The chain grates are the largest in the United Kingdom. The condenser circulating system provides for great variations in water level by reason of the tide.

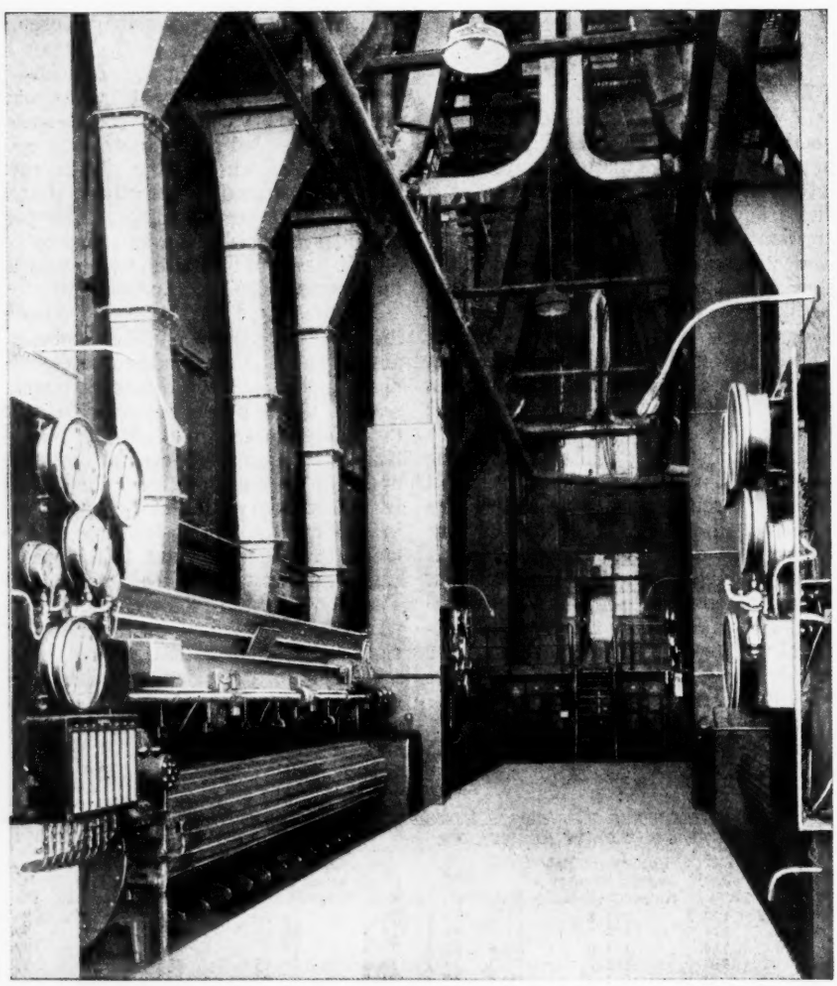
The boiler house contains four straight-tube cross-drum boilers, each rated at 80,000 lb. of steam per hour at 325 lb. gage and 725 deg. F. Convection-type superheaters and steel tube economizers are employed.

The chain-grate stokers are 24 ft. wide, the widest in commission in England, and have an active area of 432 sq.ft. each. They are driven by totally inclosed squirrel cage induction motors. As is usual in similar installations in the United States, combustion air is controlled over the length of the grate by means of compartments 2 ft. wide extending across the width of the stoker. Air is supplied to each compartment from common wind boxes on each side of the setting and is regulated by adjustable dampers. The forced-draft fans, of the double-inlet type, are in the basement, there being one fan per boiler. The induced-draft fans, one over each boiler, have dust arresters in the discharge, dust being conveyed by chutes to the ash hopper in the basement. Steam jets in the stacks serve as a stand-by to the induced-draft fans.

Feed-water supply piping is in duplicate, one turbine-driven and two motor-driven pumps being used. Interconnected piping permits of either feed main being available to serve all boilers. All clean water drains are collected and passed through a cooler to the main condenser for deaëration and return to the feed system.

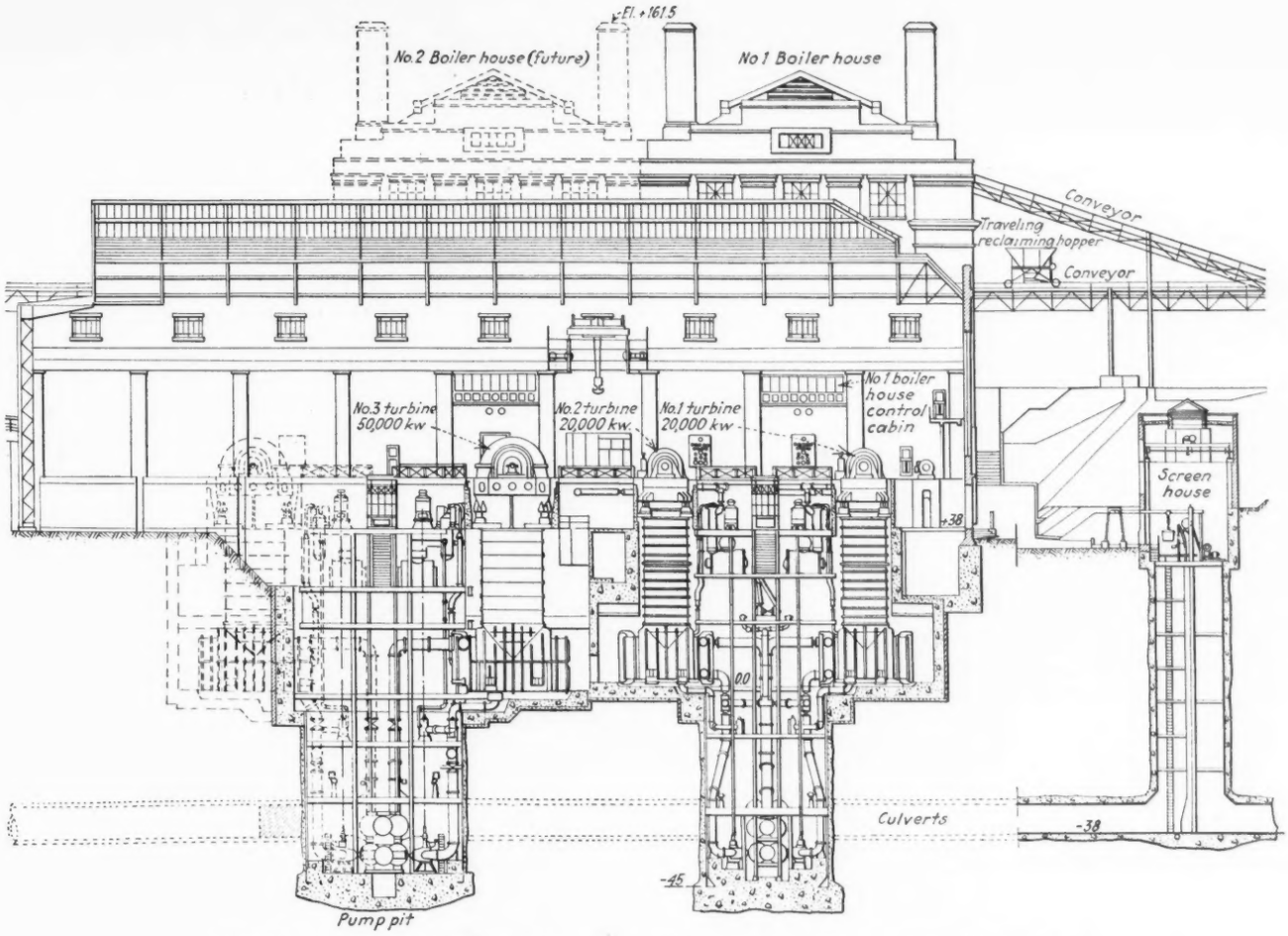
The condensate system operates on the closed-circuit principle, condensate being withdrawn from the condenser hotwell by either one of two extraction pumps, and is delivered through two main and two auxiliary feed heaters to the boiler-feed pumps. The main feed heaters are supplied with steam extracted from low-pressure stages in the turbine, while auxiliary heaters utilize exhaust steam from the air ejectors and leakage steam from the high-pressure turbine glands. The temperature of the condensate is thus raised from 80 deg. F. to 197 deg. before being passed to the economizers. A constant head on the system is maintained by a surge tank.

Make-up water is added to the system from evaporators operating with sea water and supplied with steam diverted from a low-pressure stage of the turbine. Vapor from the evaporators is



Boiler house of Portishead generating station

[1]Information obtained from a brochure recently sent out by the Metropolitan-Vickers Electrical Company, Ltd., which acted as manager and agent for the main contractor, Vickers, Ltd., of London.



Sectional elevation of station, showing screen wells, pump pits, and interconnecting culverts

discharged to the steam space of the low-pressure heater, no separate condensers being required. Tanks of 60,000 gal. capacity provide a stand-by reserve of evaporated water which is discharged as required into the condenser for deaëration before entering into the feed system.

Ashes are handled by two lines of water-sluicing troughs, each designed to care for a battery of three boilers. These lines deliver into an ash sump, from which the ashes are taken by specially designed elevators that discharge on to a belt conveyor. Transfer is made to another conveyor that deposits the ashes in a 60-ton concrete bunker located to deliver into railway cars or road vehicles.

Each of the two main generating units is driven by two-cylinder impulse turbines rated at 20,550 kw. The high-pressure cylinder contains 20 stages. The low-pressure cylinder is of the divided-flow type. After expanding through two stages in the low-pressure cylinder the steam is divided, one-half being diverted to the second half of the cylinder, from which it proceeds through three expansion stages to the condenser, while the remainder of the steam is expanded through one ordinary and one multi-exhaust stage to the common exhaust.

Each turbine drives a 25,000 kva. alternator supplying 3-phase 50-cycle current at 11,000 volts; a 600-kva., 550-volt house-service alternator; and,

Results of Tests Made on One Boiler

Data on Boiler Plant

Boiler, straight-tube, cross-drum	Vickers Boiler Co.
Steam making surface, sq.ft.	14,909
Superheater surface, sq.ft.	1,610
Economizer surface, sq.ft.	13,300
Stoker, chain-grate, forced-draft	Illinois Stoker Company
Grate area, sq.ft.	432
Drive	Totally inclosed squirrel-cage motor
Coal—Proximate analysis as received:	
Moisture, per cent	6.70
Volatile matter, per cent	31.43
Fixed carbon, per cent	53.72
Ash, per cent	8.15
Heat value, B.t.u.	12,474

Test Results

Duration of test	6 hr., 10 min.
Fuel:	
Coal consumed per sq.ft. of grate, lb.	22.2
Mean thickness of fire, in.	4¾
Percentage of ash to fuel burned	6.2
Water:	
Temperature of feed water to economizer, deg. F	139
Temperature of feed water to boiler, deg. F	254
Evaporation per lb. coal, actual, lb.	8.32
Evaporation, lb.	10.98
Steam:	
Pressure, gage	309
Final temperature, deg. F	733
Flue gases:	
CO_2 at econ. outlet, per cent	12.23
Gas temperature boiler outlet, deg. F	661.4
Gas temperature econ. outlet, deg. F	319
Drafts:	
Induced draft furnace, in w.g.	0.15
Induced draft boiler outlet, in w.g.	0.47
Induced draft, econ. outlet, in w.g.	1.20
Pressure r.h. windbox, w.g.	2.67
Pressure l.h. windbox, in w.g.	2.50

Heat balance:	B.t.u.	Per Cent
Heat used in boiler and superheater	9,726.08	81.16
Heat used in econ.	956.80	7.99
Heat used in boiler, sup. and econ	10,682.88	89.15
Heat lost in dry flue gases	863.90	7.21
Heat lost in carbon in ash	212.04	1.76
Radiation and unaccounted for	224.18	1.88

in addition, the house-service exciter. Each main alternator is excited by two motor-generator sets connected to separate sources of power, each capable of supplying all of the excitation current.

The generators connect to the 11,000-volt terminals of a 25,000-kva. transformer bank, stepping up to 33,000 volts. All switching and synchronizing is arranged on the 33,000-volt side. Main switch gear is of the metal-clad compound-filled, draw-out type incorporating full interlocking features.

Central-flow condensers serve the turbines. To reduce pumping losses to a minimum, pumps are installed 45 ft. below the turbine-room floor, the interconnecting trunk being 11 ft. in diameter. In these condensers air is withdrawn from the center of a nest of tubes, while the steam is admitted around practically the entire periphery. The design gives a low pressure drop between the steam inlet and the air pump suction, with a correspondingly high rate of heat transference. Owing to its high temperature the condensate is effectively deaërated in the condenser itself.

Each pair of main units in the turbine room is served by a circulating water pump pit sunk to a depth of 99 ft. below the turbine-room floor. Each condenser is served by two vertical-spindle pumps operating together and having a combined capacity of 1,500 gal, per minute. The pumps at the bottom of the pit are driven through vertical shafts by motors installed in the turbine room basement, 80 ft. above. Two general-service pumps of 1,000 gal. per minute capacity each are connected to the discharge side of the circulating water pumps for supply to the alternator air coolers and the turbine and transformer oil coolers.

The circulating water supply is brought in from the River Severn through four constant-level culverts, each having an internal diameter of 7 ft. 6 in. At a point adjacent to the turbine room the culverts are intercepted by the screening shafts, which are 17 ft. in diameter and 66 ft. deep. The screening plant is capable of dealing with the required quantity of circulating water at all levels of tide over a range of 52 ft. Screens are of the traveling-band type, on 73 ft. 4 in. centers. Interconnector mains permit of any culverts being used at will either for suction or discharge, direction of flow being determined by a series of sluice valves operated by submersible-type motors controlled from the turbine room.

After the plant had been completed, a six-hour test gave the results appearing in the accompanying table, which also contains the technical data of the boiler plant and the proximate analyses and heat value of the coal as received. An evaporation from and at 212 deg. of 10.98 lb. with 12,474-B.t.u. coal is indicated. Under operation at the normal rating of 80,000 lb. per hour the heat balance shows a boiler and superheater efficiency of 81.16 per cent. Including the economizer, which uses 7.99 per cent of the heat, over-all efficiency of the boiler unit is 89.15 per cent, a remarkably high value for an installation of moderate size.

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Boiler Manufacturers Adopt Code for Boiler Support Structures

AT THE recent meeting of the American Boiler Manufacturers Association a report was presented on boiler suspensions. This report had previously been circulated among the members of the association for suggestions. As adopted at the meeting, it recommends the use of the following material and stress values in the construction and design of structures for the support of boilers:

Columns shall be made of material of quality not inferior to that required by A.S.T.M. specification No. A9-24 and shall have a maximum $\frac{l}{r}$ ratio of 120 for a maximum fiber stress of 16,000 lb. per square inch. No credit shall be taken for casual connections between supporting columns, nor for abutting brickwork. When cross ties are used, designed specifically for the purpose of strengthening columns, credit may be taken for such ties, which, however, may be designed with both a horizontal and vertical maximum $\frac{l}{r}$ ratio of 140.

Cross girders or beams shall be of material of quality not inferior to that required by A.S.T.M. specification No. A9-24 for structural steel, and the maximum tensile fiber stress shall not exceed 16,000 lb. per square inch. Lateral deflection of beams shall be provided for in accordance with the practice recommended by the American Institute of Steel Construction as the minimum requirement.

Hanger rods when made of open-hearth material of quality not inferior to that required by A.S.T.M. specification No. A9-24 for structural steel may be allowed a maximum unit tensile stress of 14,000 lb. per square inch if not bent or otherwise distorted. If bent or distorted the maximum unit tensile stress shall be 12,500 lb. per square inch. If made of higher tensile strength material in accordance with any A.S.T.M. specification for bridge or structural steel hanger rods, the maximum allowable unit stress may be increased in the same proportion that the minimum tensile strength of the range for the special material exceeds the minimum of the range of the A.S.T.M. specification. If material of unknown quality is used the maximum unit stress shall be 8,000 lb. square inch when straight and 7,500 lb. if bent or otherwise distorted.

The least area at any point in the hanger shall be used to determine the unit stress carried.

The loads on all supporting members shall include all possible weights that may have to be carried when the boiler is set up filled with water for hydrostatic test and ready to operate with all piping, breechings, superheaters, etc., attached.

Any member of a supporting structure so located that any loaded part or portion thereof may be heated to a temperature in excess of 400 deg. F. shall be designed for a maximum unit stress 10 per cent less than that authorized for temperatures under 400 deg. F. No part or portion of any supporting structure subject to load shall be so located or unprotected as to become heated to a temperature in excess of 600 deg. F.

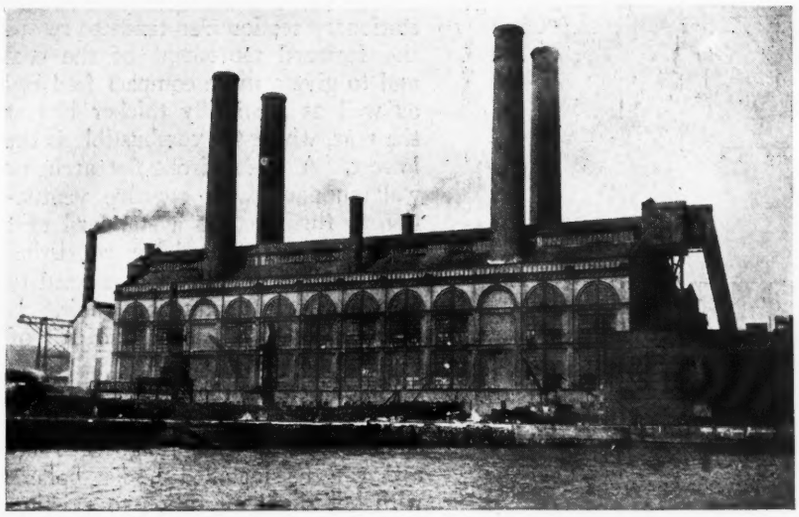
The limitations herein provided are intended to apply only to the usual type of independent boiler support, or to that part of other structural work which replaces such support.

Power Potentialities of Umpqua River Basin

THE TOTAL potential water power of the Umpqua River Basin, in Oregon, without storage, is 243,000 hp. for 90 per cent of the time and 573,000 hp. for 50 per cent of the time, according to the Geological Survey, Department of the Interior. If storage were provided these figures could be increased to 354,000 and 549,000 hp. With unified operation of all proposed plants the power available 90 per cent of the time with storage could be increased in an average year to more than 400,000 hp., of which 350,000 hp. would be on the Umpqua nad North Umpqua rivers, 15,000 hp. on the Clearwater River, 9,000 hp. on Mill Creek, and the rest on smaller tributaries.

The Umpqua, North Umpqua, and Clearwater rivers are valuable power streams with large fall and well-sustained flow, and the Umpqua and North Umpqua have possibilities for storage. Mill Creek, a tributary of the Umpqua River, has possibilities for storage and a concentrated fall, so that it also is valuable for power. The South Umpqua River and Steamboat Creek, a tributary of the North Umpqua, have some potential power value, but it is questionable whether the sites on these streams can ever be economically utilized.

These and other pertinent facts are set forth in Geological Survey Water-Supply Paper 636-F, prepared by Benjamin E. Jones, hydraulic engineer, and Harold T. Stearns, geologist, which may be obtained from the Superintendent of Documents, Washington, D. C., for 40 cents.



Lots Road power house, which has been furnishing power to the London "underground" since 1905, is being completely revamped to carry the growing load with greater efficiency

More Power for London's Underground System

LONDON'S "underground" system (British counterpart of New York's subways) has experienced a growth in traffic which has necessitated continued increases in the capacity of plants supplying it. In 1908 the total car mileage on railways suplied by Lots Road power house was 32,500,000. The estimated figure for 1930 is 96,250,000, an increase of about 196 per cent.

Lots Road power house was completed in 1905 to provide electric current for operation of the Metropolitan District Railway, and the three tubes that now form the London Electric Railway. When inaugurated it represented the most modern and efficient installation of its kind in the world, the 6,600-kw. turbine-alternator being the largest that had yet been built.

In 1925 it was recognized that further additional demands on the power house could not be met adequately except by replacing practically the whole of the original plant.

The generating plant, on completion of the present program, will comprise nine Parsons 15,000-kw. turbine-generators with a station load of 105,000 kw., two sets being stand-bys. A further installation of two 15,000-kw. units is contemplated. Thus far the work actually completed is attested by an increase in the station output from 70,000 kw. in 1925 to 90,000 kw. in March, 1930. By the autumn of the present year the output will be 95,000 kw. Increasing capacity has been accompanied by a commensurate increase in efficiency.

This process of reconstruction and improvement has, of necessity, been slow, it being necessary to maintain underground service at all times. Construction has now been carried on for five years and will be completed next year, total cost of the program being over $5,000,000.

Original turbine equipment consisted of eight turbine-alternators of 6,000-kw. capacity each. Three extra sets, each of 15,000 kw., were installed, the first in 1915, another in 1921, and the third in 1925.

Since the latter date three of the old 6,000-kw. sets have been removed and replaced by three 15,000-kw. machines. Another 15,000-kw. set is now in course of erection, displacing a fourth 6,000-kw. set.

The two latest large sets are working at a higher steam pressure and temperature (275 lb. and 650 deg.). The other four large sets are running under the old steam conditions (185 lb. and 500 deg.). With the exception of the sets erected in 1915, all these machines are capable, with a minimum of alteration, of conversion to the higher steam pressures.

The whole of the high-tension switch gear is being replaced, the new switches having a rupturing capacity of 750,000 kva. Generator reactors are being installed.

An entirely new high-tension control board has been erected in the new control room at the eastern end of the engine room building, and the existing control board on the gallery will be dismantled. Old auxiliary equipment operated at 220 volts alternating current, but this is being changed over to 440 volts alternating current, and the auxiliaries on the two latest turbine-alternators are working at the higher voltages.

Original boiler equipment consisted of 64 Babcock & Wilcox land-type units, each having a capacity of 16,000 lb. of steam per hour at a pressure of 200 lb. and a temperature of 500 deg. Eight new boilers of the C.T.M. type, made by the same firm, have been installed, four in 1922 and four in 1925. All of these have a capacity of 39,000 lb. per hour at 290 lb. pressure and 700 deg.

To facilitate the general reconstruction without reducing station output, four new C.T.M. boilers have been erected outside the western end of the main boiler house. These have a capacity of 50,000 lb. per hour each at the higher pressure and temperature, and they have been in service since 1927.

To date sixteen of the old boilers have been removed and replaced by eight new ones of 50,000 lb. capacity, working under the higher steam conditions and supplying the two latest large turbines. The remaining boilers are at present working on the low-pressure steam system.

Eight further large boilers (of 50,000 lb. capacity) are in course of erection, replacing the second batch of sixteen old boilers, which have been removed.

All of the new boilers are equipped with balanced draft equipment, the 50,000-lb. boiler having compartment-type stokers. Each boiler has a superimposed steel economizer.

Steel work supporting the coal bunkers is at present being overhauled and renewed where necessary. At the same time two partitions are being built in the large bunkers between the four original brick stacks.

The old system of hauling ashes by skips has been replaced by a water-sluicing system, discharging into a sump built in the yard at the west end of the power house. From this sump ashes are grabbed by a telpher crane, and can be passed either through screens for sizing or discharged into barges in Chelsea Creek.

Two electrical feed pumps and one steam pump are in service on the higher pressure system. A third new electrical feed pump is in service on the low-pressure system. The circulating water system is being entirely rebuilt.

A new artesian well has been sunk in the yard at the east end of the power house. This is fitted with an electrically driven centrifugal pump.

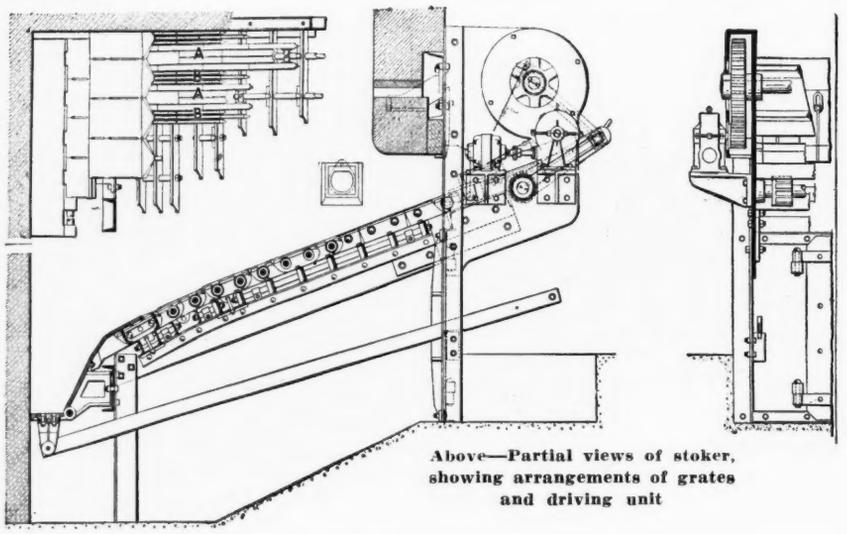
WHAT'S NEW IN PLANT EQUIPMENT

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING, TRANSMITTING AND APPLYING THE POWER SERVICES

Multi-Feed Stoker for Boilers Up to 2,500 Sq.Ft. Heating Surface

A RECENT ADDITION to the line of Stowe Stokers put out by Johnston & Jennings Company, 877 Addison Road, Cleveland, Ohio, is the "multi-feed" unit illustrated, suitable for use with boilers ranging from 750 to 2,500 sq.ft. of heating surface.

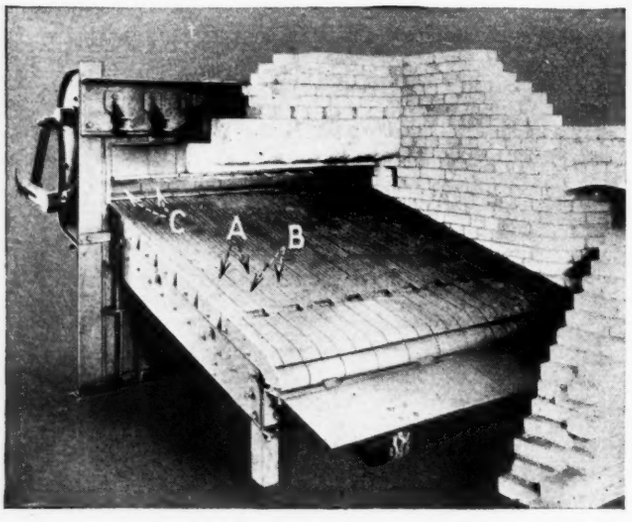
The grate surface, which is flat and slightly inclined, is made up of moving grates *A* and stationary grates *B*, the stationary sections comprising about 35 per cent of the entire grate area. Coal is fed on to the grate by pusher plates *C* operated by a rack and pinion. The pusher plates are attached to the moving section of the grate, and the amount of back-and-forth movement is readily adjustable to meet various conditions and give various rates of burning. The adjustment is made by sliding one end of the connecting rod along a slotted lever attached to the pinion shaft, as shown at the left.



Above—Partial views of stoker, showing arrangements of grates and driving unit

At the rear end of the grate a stationary housing, or section, is provided, its purpose being to delay the discharge of the ash and thereby reduce its combustible content. This stationary section also tends to retard the forward movement of the coal and to give a more compact fuel bed as well as a slightly thicker bed at the rear, where the combustible is the lowest. A 13-in. front flat arch, or wall support, with overfire ventilation is furnished as a standard part of the stoker. The drive, consisting of a small motor direct connected to a worm-gear reduction unit, is mounted on brackets at one end of the coal hopper.

Among claims made for the stoker by the manufacturer are that it is adaptable to a wide range of fuels and can be installed under boilers with but slight alteration to existing settings.



Left — View of stoker from the rear

Improved Traveling Water Screen

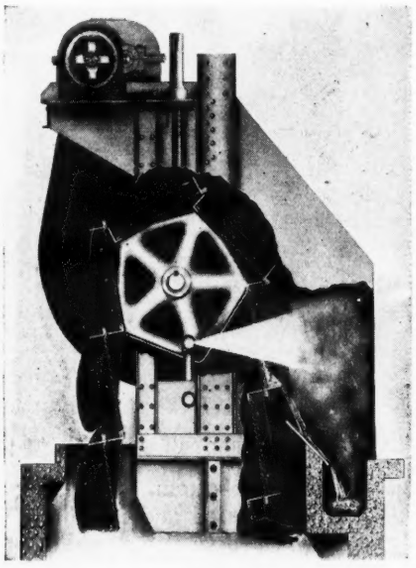
IN THE new 1930 model traveling screen shown, in part, in the accompanying illustration, the Link-Belt Company, Chicago, Ill., has introduced a number of changes in the design that should improve operation. In a recent announcement particular stress is alid on the new tray construction, which has resulted in approximately 10 per cent greater depth of effective screening areas.

To withstand maximum pressures encountered during flood and tide emergencies, the trays are made of heavy-section angle irons, with one-piece frames. Another feature is the overlapping of the trays and the use of seal plates between the ends of the trays and the elevating chains to which they are secured. Since the space between trays in the guides and in the boot is reduced to a minimum,

the passage of trash is prevented at these points. The openings between trays are actually smaller than the openings in the screen. Chain wear does not affect the overlapping feature.

The driving arrangement is a new development of standardized power-transmitting units, consisting of a motor with moisture-proof windings, a herringbone gear, fully housed speed reducer running in oil and equipped with anti-friction bearings, and a suitably guarded finished-steel roller chain drive to the screen head-shaft.

Reference to the illustration will show the construction of the trays, the location of the driving motor on top of the screen, and the front-spray



Head section of latest-design "Clean-Water" intake screen with front spray

method of washing the refuse from the ascending trays into a gutter. An alternate method of removing the trash is to provide on the descending run dual back sprays in which the upper sprays wash out the heavier material directly into the gutter and the lower sprays remove the smaller particles clinging to the screen cloth.

Improved Thermostat for Heating Control

THERMOSTAT 855 brought out by the Mercoid Corporation, 564 West Adams St., Chicago, Ill., requires no relay and will operate directly where the normal current working load does not exceed 10 amp. at 110 volts or 5 amp. at 220 volts. A thermal element protrudes from the front of the instrument and is there-

Mercoid thermostat No. 855

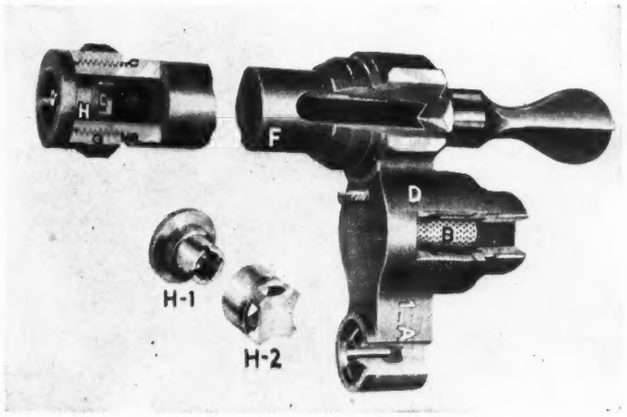
fore exposed directly to the atmosphere.

The inclosed fluid in the thermostatic element as it expands or contracts actuates a plunger which, in turn, operates the movement by throwing the switch to the "on" and "off" position. The new design eliminates the usual ventilating apertures in the cover.

All adjustments are protected within the instrument but are readily accessible by moving two screws which hold the cover in place. Standard operating range is from 56 to 80 degrees.

Mechanical Oil Burner With Compound Tip

IN THE new, type B, non-adjustable oil burner put out by the Coen Company, Inc., Story Bldg., Los Angeles, Calif., important features of the type A burner have been retained, with the burner stem spring and stuffing box (used with the type A) eliminated. This improved design gives a comparatively simple burner consisting, essentially, of burner head *D*, tube or barrel *F*, and



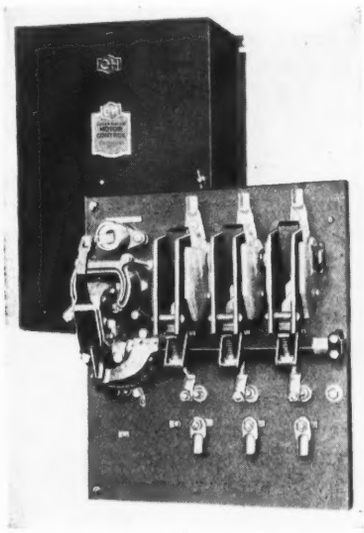
Type B non-adjustable burner with compound tip

compound tip *H*. The compound tip is made up of the two parts *H-1* and *H-2* shown in detail. Part *H-1* contains both the outlet orifice and the atomizing chamber with tangents. Part *H-2* is a thimble for the atomizing chamber. Both are of steel.

The use of the compound tip, with the double diameter atomizing chamber, and tangents set well back from the outlet orifice, produces, according to the manufacturer, a fine degree of atomization even at low pressure, giving the burner a load range over 100 per cent without changing tips.

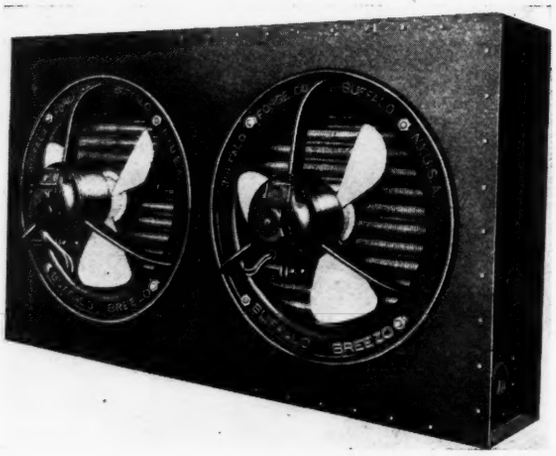
Heavy-Duty A.-C. Contactors

TWO magnetic contactors, for heavy-duty alternating current service, are announced by Cutler-Hammer, Inc., 190 12th St., Milwaukee, Wis. Rated for maximum capacities of 300 and 600 amp., re-



300-amp. magnetic contactor

spectively, they are arranged for either two- or three-wire control, have continuous-duty operating coils, and exceptionally heavy, butt-type, solid-copper contacts. An air cushion absorbs the shock of the magnet on closing, thus tending to reduce wear and make the contactor operate more quietly.



Single heating element with two 16-in. fans

Twin-Fan Unit Heater in Three Sizes

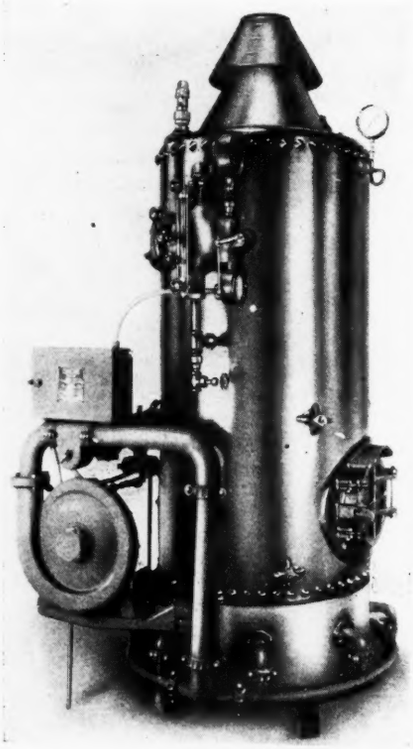
MADE in three sizes for steam pressures up to 40 lb., the new unit heater designated "Twin Breezo-Fin" recently introduced by the Buffalo Forge Company, Buffalo, N. Y., employs two 16-in. fans mounted on a single heating unit as illustrated. The smaller capacity fans are driven by $\frac{1}{20}$-hp. motors, and the units are rated at 2,070 c.f.m. Details of the other two models are, $\frac{1}{10}$-hp. fan, 2,800 c.f.m.; and $\frac{1}{8}$-hp. fan, 3,505 c.f.m. The heating element is made up of Aerofin coils, and only one set of steam and drip connections is necessary. With the fan's motors connected for separate control one fan may be shut down when desired, thus reducing the steam consumption of the unit.

Small Gas-fired High-Pressure Boilers

FOUR additional sizes of gas-fired high-pressure boilers have recently been added to the line of small boilers put out by Steam & Combustion Company, Chicago, Ill. The new units, which are made in capacities of 350, 450, 600 and 800 lb. of steam and hour normal rating, embody the important features of the larger boiler units put out by the same company. Each unit is a complete steam generating plant, consisting of a vertical fire-tube boiler shell, furnace, burner system, and controls.

A water leg of the mud-ring type surrounds the combustion chamber. Tubes are $1\frac{1}{2}$ in. outside diameter, and each is fitted with a restrictor to improve circulation and heat transfer. The combustion system comprises a gas burner of the forced-draft type, with the burner tuyères placed in a radial-tangential arrangement as shown. The burner base is lined with insulating and refractory materials, which tends to improve combustion.

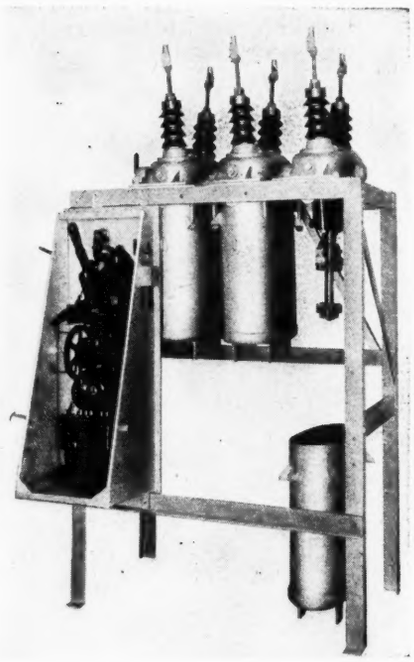
All combustion air is supplied by a motor-driven blower. Air under pressure draws gas from the supply line and forms a complete combustion mixture before reaching the burners. In this way the excess air can be held to a minimum. Other automatic control features with which each unit is equipped are off-and-on operation of burner system, low-water safety cut-out, pilot-light safety cut-off, and water level regulator. The automatic turn-down, a feature of the larger boilers, is omitted in the small series in the interest of simplicity.



Boiler with complete combustion and control equipment

Moderate-Capacity Oil Circuit Breaker

AN OUTDOOR oil circuit breaker (type O-11) of moderate interrupting capacity for outdoor distribution services of 15,000 volts or less is illustrated. The pole tops are fabricated of hot-rolled steel plate, and the tanks are of heavy-gage steel, elliptical in shape and heavily welded



Circuit breaker for outdoor service

at the ends and bottom. The tank bottom is hot-pressed and reinforced by angles which serve also as grounding lugs. Inverted laminated brushes are protected on closing and opening by exceptionally large arcing contacts.

Design of the operating mechanism embodies the important features of easy closure and at the same time affords ample pressure at the contact surfaces. Provision is made for two bushing-type current transformers per pole. Series-type current transformers mounted within the breaker tank may also be supplied.

The breaker, which is manufactured by Condit Electrical Manufacturing Corporation, Boston, Mass., is available for 600 and 800 amp., manually or electrically operated (alternating current and direct current). The estimated interrupting capacity is 5,000 amp. at 15,000 volts.

✦

INCREASES PIPE SIZES—The Reading Iron Company, Reading, Pa., manufacturers of puddled wrought-iron pipe in sizes from $\frac{1}{8}$ to 20 in. in diameter, has increased its range to include 22 and 24-in. pipe.

NEWS of the FIELD

Spot News

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LIEUT. GENERAL EDGAR JADWIN, *retired, former chief of engineers of the United States Army, has been appointed chairman of the reorganized Federal Power Commission by President Hoover, according to an announcement of the President on July 1. General Jadwin has accepted the post, and his appointment goes to the Senate for confirmation.*

•

AFTER NINE YEARS *of debate, Congress has removed all obstacles in the path of construction of the Boulder Dam project. Over the protest of the Arizona Senators, the Senate approved, on June 27 the $10,660,000 appropriation for starting work in the second deficiency bill. Barring court interference, there is nothing now to prevent the project from being carried to completion.*

•

ANNOUNCEMENT *is made that the Ontario Hydro-Electric Power Commission is planning to erect in Toronto a new 220,000-volt transformer station, costing approximately $6,000,000. The new station will receive power from the Chats Falls development on the Ottawa River and the Beauharnois development on the St. Lawrence, two of the largest hydro-electric projects now under construction in Canada.*

•

AFTER MUCH CONTROVERSY *in the Senate over the sale of power by Muscle Shoals plants exclusively to the Alabama Power Company, the Senate Committee on Agriculture and Forestry reported favorably July 1 on a joint resolution, introduced by Senator Norris, authorizing the Secretary of War to sell power from Wilson Dam to states, counties, and municipalities as well as private corporations. Assertions were made in the debate on the issue that a large part of the firm power at the shoals is now going to waste.*

Construction Plans Discussed for National Hydraulic Laboratory

John R. Freeman submits estimates and stresses importance of large-scale equipment at advisory committee meeting

CONSTRUCTION plans for the National Hydraulic Laboratory were initiated recently by a special advisory committee meeting in Washington. Hydraulic engineers from all federal departments concerned and from private practice attended at the call of Dr. G. K. Burgess, director of the Bureau of Standards, where the new laboratory is to be. Now that an appropriation of $350,000 for construction and $50,000 per year for operation is going forward in the second deficiency bill, the plant is to be built as soon as suitable plans have been formulated. No announcements have been made as to appointing a director though several names are being discussed.

According to Dr. Burgess, the meeting was a successful and harmonious one wherein numerous ideas were advanced concerning the plant set-up and its use. John R. Freeman, recognized as the "father" of the project, presented detailed plans and estimates showing that a laboratory equal to any in the world can be constructed with the funds provided. His plans call for a building 424 ft. by 76 ft. with wings 100 ft. wide at each end, on the hillside site selected. The main part of the design is based on the large forebay, flume, and measuring basin which are the most important features. The forebay would be a steel tank 40 ft. high and 40 ft. diameter supplying water in any quantity up to 500 sec.-ft. and any head up to 40 ft. The flume would be 16 ft. deep by 15 ft. wide, making it possible to test weirs and dam models with a flow depth up to 6 ft. over the weir crest. Weir and dam formulae now in use are from much smaller scale experiments. A measuring basin of 80,000 to 100,000 cu.ft. capacity would be provided to record volumes of water from which discharges could be computed within one-tenth of one per cent. The water would be recirculated by a pumping plant. Other features contemplated are: a flume 220 ft. long and 10 ft. wide in which models of river sections could be tested at any slope up to 5 per cent; a siphon spillway with full atmospheric suction and depth over crest up to 12 ft.; small flumes with glass sides for most of the routine testing; and facilities for testing pumps.

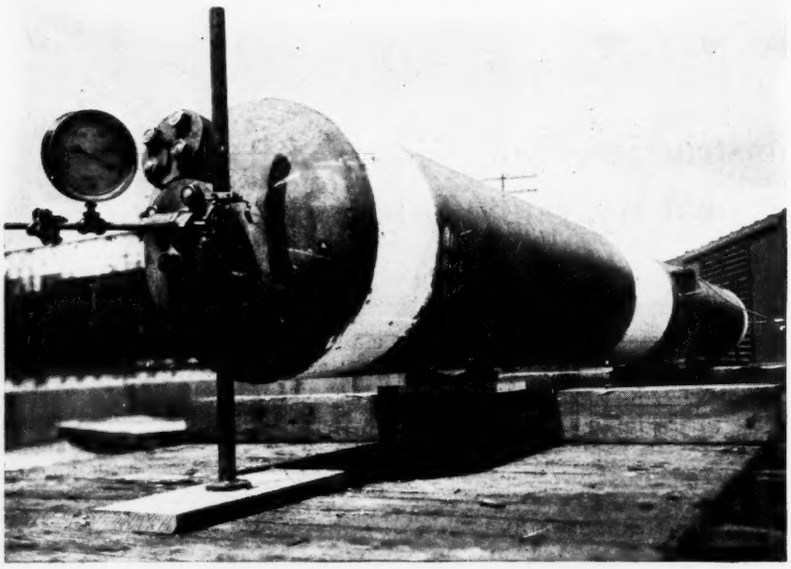
Dr. Freeman surprised the committee by showing two independent estimates whereby all the above features and more could be provided within the appropriation. The Turner Construction Company's estimator had arrived at a figure of $341,715 and the Charles T. Main Company at $354,885. It was stated that the specifications were so liberally drawn that these preliminary figures could be reduced by cutting down on certain items. The Bureau had been thinking heretofore of flow in somewhat smaller quantities, planning to erect the building first with limited equipment and to expand according to later needs. No commitment to any definite plan will be made till the committee has reported.

IT IS Dr. Freeman's contention that large-scale equipment be provided above all things and that the building must be built around such equipment rather than fitting in the flumes and tanks afterward. He states that "scale effect" is a very moot question, since outstanding hydrologists take opposite sides as to how far the results from small-scale models can be extrapolated to cover phenomena where large flows are involved. Thus, it is pointed out, large-scale facilities are paramount, not only for new lines of research but to check back on old experiments where the discharge was comparatively limited.

It is expected that the new laboratory will be operated principally along the lines of specific problems with incidental elements of theoretical interest but that matters of pure theory also will be subject to extensive study.

Among other members of the committee in attendance at the meeting were: Dr. S. M. Woodward of Iowa State University; L. F. Moody of the Cramp Morris Company, Philadelphia; and B. R. Van Leer of the American Engineering Council staff. Dr. W. B. Gregory of Tulane University and E. C. Hutchinson, editor of *Power*, were at the World Power Conference in Berlin. Dr. Freeman will join Dr. Gregory in Germany and will inspect some of the modern European laboratories as a basis for further suggestions. Meanwhile the committee is to meet again on July 14.

Welded Chrome Vanadium Pressure Vessel Tested to 10,000 Lb. per Sq.In.



THE SEVEREST TESTS to which a welded vessel has ever been subjected, reaching pressures of 10,000 lb. per square inch, were recently completed at the plant of the A. O. Smith Corporation in Milwaukee.

The vessel tested is a reaction chamber built of chrome vanadium steel by welding for 5,000 lb. per square inch working pressure in a chemical process. Walls are 3½ in. thick. The vessel is 33 ft. long, with 26-in. inside diameter.

Following routine repeated stress tests and hammer tests at 8,000 lb., the pressure in the vessel was raised to 10,000 lb. per square inch and the entire vessel was carefully examined. As shown in the accompanying illustration, there was no scaling of the lime wash. Careful measurement and liquid volume readings showed that the vessel took no set or permanent distortion from the extremely high test pressures.

The vessel was shipped for installation on the same night that the tests were concluded.

▼ ▼ ▼

Britain's Grid System Nears Completion

A vast growth in the electricity consumption of the United Kingdom is indicated by the fact that the British Electricity Commission has recently sanctioned important additions to existing plant facilities. Increase in consumption is due to the steady spread of the grid system throughout the country. The plant extensions authorized since the beginning of April total 310,000 kilowatts.

Within a few weeks the Central Electricity Board will deal with the last outstanding area to which the national grid system is to be applied—Norfolk and a large portion of Suffolk, representing 6 per cent of the total scheme. When the East Anglian scheme has been approved the complete constructional program of the board will have been dealt with. The board has to date awarded contracts for material amounting to about $65,000,000.

The capacity of the County of London Electric Supply Company's station at Barking is to be enlarged by 150,000 kw., while the Brimsdown power station is to be increased by an additional 50,000 kw., and a further 40,000 kw. is to be added to the London County Council's plant. These extensions will mean an expenditure of more than $20,000,000.

Last year Great Britain consumed 8,596,000,000 kw.-hr. of electricity, an increase of 993,000,000 kw.-hr., or 13 per cent, over 1928.

Plan Large Hydro Projects for Alaska Paper Mills

Initiation of a great industry in Alaska is seen in the applications to the Federal Power Commission for licenses covering large developments of power in connection with the establishment of a pulp and paper mill. The applicants are George T. Cameron of San Francisco, with whom is associated Harry Chandler, of the Los Angeles *Times*, and the Zellerbach Corporation. Each of these applicants is planning to develop power sufficient to operate plants with a daily output of 500 tons. In each instance, however, the immediate installation will be for 250 tons daily.

The Cameron development consists of a tunnel 8,500 ft. long, extending from Long Lake to a power house on the shore of Speel inlet, and a tunnel 6,300 ft. long from Crater Lake to the same power house. A third tunnel will connect another power house with Dorothy Lake. The estimated capacity at the Speel inlet power house is 35,935 hp. At the other power house the capacity will be 24,335 hp. It is proposed to install equipment sufficient to generate 87,000 horsepower.

The power house for the Zellerbach plant will be developed at the outlet of six lakes known as Mirror, Ella, Manzanita, Swan, Grace, and Orchard. There are to be five power houses with a total installation of 80,000 hp. The primary power to be made available is 47,000 horsepower.

Riverton Makes Record for Fuel Economy

The Riverton plant of Empire District Electric Company at Riverton, Kan., set an all-time record for fuel economy in April, with 21,648 B.t.u. per net kilowatt-hour produced, exceeding by 806 B.t.u. the previous high month, according to a report of G. C. Pratt, general superintendent, just published by the *Doherty News*.

This efficient and economical record in kilowatt-hours per pound of coal and per thousand feet of gas consumed in boilers of the plant was achieved through the co-operation of George W. Irey, plant superintendent, and the entire plant force.

Contributing to the fine results obtained was a series of improvements which have been made in the last two years. These included the placing of soot blowers on boilers, installation of the continuous blowdown system, use of condensers on the feed-water heaters and a general improvement in feed-water treating.

Reports Show Increase in Interstate Power

On the heels of a National Electric Light Association announcement that the interstate transmission of power was 11.8 per cent of the total United States output in 1929, comes a conflicting statement from the Federal Trade Commission saying that the interchange was nearer 16 per cent. The difference doubtless is due to the fact that the higher figure is based on gross transfers whereas the N.E.L.A. report contains some individual cases where the net basis is used.

The 16 per cent figure is said to

underestimate rather than exaggerate because of a tendency to disregard back flow over a line where the major movement is in the other direction and meters do not register both ways. A factor toward overestimating might result from cases where power lines recross a state line several times or cross two lines without significant distribution between the termini.

For the total interchange, the commission gives 14.5 billion kilowatt-hours or 15 per cent of the total 97.4 billion kilowatt-hours reported by the United States Geological Survey for 1929. The N.E.L.A. gives 10.8 billion kilowatt-hours or 11.8 per cent on a total of 91.7 billion kilowatt-hours central station power. Reducing the Trade commission's figures to include only the central stations gives the 16 per cent figure generally comparable with the conflicting estimate of 11.8 per cent.

The Commission's estimate is not final but the questions yet to be cleared up are not expected to shake the conclusion materially.

No Action on Museum Bill

Action in the Senate on the bill to establish a national museum of engineering and industry has been postponed. The bill, introduced by Senator Copeland, of New York, was brought up on the calendar on June 24. Senator Jones, of Washington, however, objected to hasty consideration of so important a measure. He said he believes that there should be more opportunity to study the matter. The bill was therefore passed over and action this session is doubtful. Senator Copeland's bill contemplates the establishment of a suitable museum for engineering and industrial exhibits and authorizes creation of a commission to study the matter.

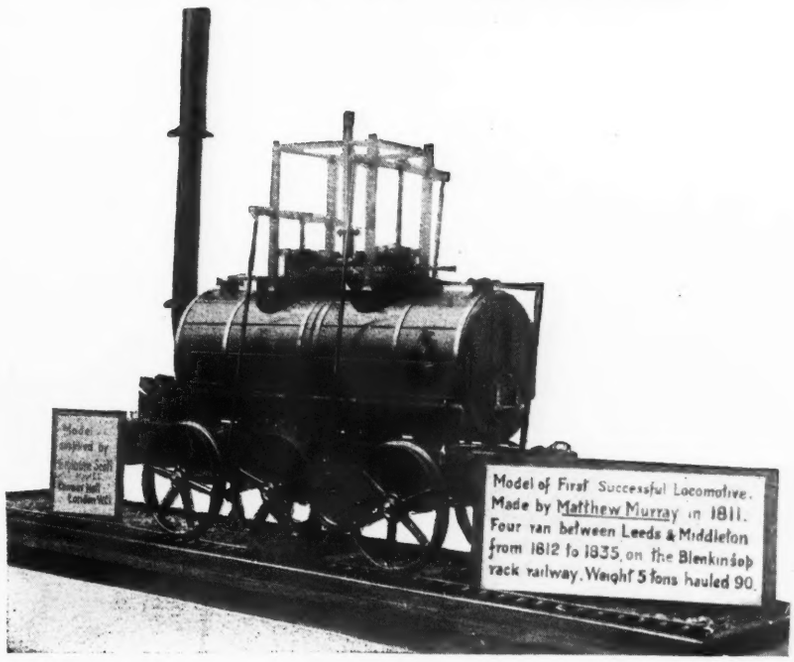
Municipal Plant Officials of New York to Meet

The officials in charge of municipal electric light plants in New York State will meet in Jamestown on July 11 to perfect a state organization. The meeting has been called by the New York State Conference of Mayors and other municipal officials at the request of several municipalities which operate electric light plants.

The meeting will be in charge of Mayor Samuel A Carlson of Jamestown, a former president of the mayors' conference, and F. A. Clayton, president of the Ilion Board of Light Commissioners.

The attitude of the mayor's conference has long been favorable toward municipal regulation of public utilities and the extension of powers of municipal plants. It is not unlikely that the organization when formed will urge the Legislature to give increased powers to city-owned power plants to enable them to compete with private capital.

Model of Matthew Murray's Locomotive Presented to New York Museum


Model of First Successful Locomotive.
Made by Matthew Murray in 1811.
Four ran between Leeds & Middleton
from 1812 to 1835 on the Blenkinsop
rack railway. Weight 5 tons hauled 90.

A MODEL of the first commercially successful locomotive has recently been presented to the Museum of Peaceful Arts in New York City, by E. Kilburn Scott, prominent mechanical engineer of London, England. Designed and built by Matthew Murray, of Leeds, the locomotive commenced running in August, 1812, on a railway between Leeds and Middleton, the roadbed for which was laid in 1758.

Murray's locomotives were the first to have two cylinders with cranks at right angles. They were complete with pump, feed tank, safety valve, and other accessories for regular running. Though weighing only five tons, the locomotive was able to haul 90 tons, due mainly to the rack rail invented in 1811 by John Blenkinsop at Middleton Colliery.

In 1813 Murray made two similar locomotives for a railway line between Walker-on-Tyne and the Kenton and Coxbridge collieries, and they were the first to be put in actual operation in that district.

The locomotives built by William Hedley, George Stephenson, and Timothy Hackworth were subsequent to the advent of that of Murray's. The first locomotive of George Stephenson at Killingworth Colliery was a copy of his. The "Rocket" was made in 1828, sixteen years after Murray's locomotives had started regular daily service.

In 1816 Murray supplied the first steam engine to be put into a Mississippi River steamboat. The engine was of the double-beam type.

In 1802 Murray built a house in which he used steam pipes for central heating, and the local people called it "Steam Hall" for that reason.

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State Line Wins Right to Sell to Chicago

The United States Circuit Court of Appeals in Chicago has ruled in favor of the State Line Generating Company and against Charles B. Shedd, who through injunction proceedings sought to block the carrying out of terms of the contracts between the generating company and public utility companies of Chicago and northern Illinois for the purchase and sale of electrical energy.

Mr. Shedd, who owns land in Hammond near the Indiana-Illinois state line, a strip of which 300 ft. in width was acquired by the Northern Indiana Public Service Company through condemnation proceedings for the construction of a superpower transmission line, has been opposing the project in the courts for over two years, on the grounds that the State Line company had no right to the use of this line.

The decision of the United States Circuit Court of Appeals was handed down in an appeal from a dismissal of an injunction suit filed by Mr. Shedd in the United States Circuit Court of Indiana, Hammond division. Mr. Shedd in this suit sought to enjoin the State Line Generating Company from transmitting energy over the transmission lines of the Northern Indiana Public Service Company and selling part of it to the Commonwealth Edison Company and the Public Service Company.

News of Canada

Grand Falls to be completed soon—Second unit at Michipicoten Falls now in operation—Canadian Hydro makes record output

WITH THE installation of a fourth generator of 20,000 hp., an order for which has just been placed with the Canadian General Electric Company, the ultimate capacity of the present plant of the St. John River Power Company at Grand Falls, New Brunswick, will be reached. There are three similar generators operating at the present time, and when the fourth has been put in position the plant will be delivering 80,000 hp. The purpose of the new unit will be to meet the demands for current arising out of the installation of the second paper machine in the Dalhousie mill of the New Brunswick International Paper Company, whose plant was opened early this year. The Grand Falls energy is brought to the Dalhousie plant over a transmission line more than 100 miles long and stretching across nearly the entire northern area of New Brunswick.

THE SECOND UNIT of the Algoma District Power Company's development at Michipicoten Falls, near Sault Ste. Marie, Ontario, has been completed, supplementing the first unit of 10,000 hp., finished a year ago, and bringing the total development up to 20,000 hp. A large permanent concrete dam on the Michipicoten River above the falls will be completed before the end of this year, which will make it possible by the installation of a third waterwheel and generator to bring the development up to a total of 35,000 horsepower.

OUTPUT of the Canadian Hydro-Electric Corporation was 218,850,000 kw.-hr. in May, a new high record for a single month, and 2 per cent greater than the previous high record for a month, established in April. The May output of the corporation was 30 per cent over May last year, and over two and one-quarter times that of May, 1928.

The output of the corporation for each of the first five months of this year has showed progressively higher percentages of increase over the corresponding months of last year. In the first five months of this year the output was 1,008,319,000 kw.-hr., 21 per cent over the output of the corporation in the first five months of 1929, and over double its output in the first five months of 1928.

International Hydro-Electric System produced 347,085,000 kw.-hr. in May, an increase of 11 per cent over the output of the system in May, 1929. Output for the first five months of this year was 1,704,447,000 kw.-hr., 10 per cent greater than in the first five months of 1929.

How s Business?

WHETHER he be owner, business executive or engineer, every reader of *Power* has a direct stake in the general business situation. In view of the many ill-founded reports that are being circulated, *Power* reprints the following summary and forecast from the July 2 cover of the *Business Week:*

"The business tide reached its ebb during the past two weeks, and is beginning to turn, very slowly and tentatively, in face of a strong current of peevish, superficial, and premature pessimism. . . . There will be no noticeable change in the next few weeks. Continued liquidation in certain lines will overlap and obscure increasing resistance, stabilization, and upturn in others. . . . Progress will be slow, irregular, spasmodic, with sporadic relapses, successively less frequent and sharp, till the end of July. Then, in the same weeks when a year ago the downturn began, a decisive recovery will set in, general and definite enough to be evident even to the blue-funk brigades of business who have been enjoying their May-parties and June-walks in the cemetery. . . . . The rise of the business curve thereafter will be rapid, and will, as usual, steal a march on the slow-witted and self-centered stock market. By October it will be back to normal . . . . This forecast is not based solely on the sharp circumstantial rise in our index from the low point of 88.8 per cent of normal last week to 93.6 per cent this week. Other statistical straws suggest strongly that the confused economic currents are setting more uniformly in the direction of recovery. The adjournment of Congress will help clear the channel."

ERIK GUSTAV SOHLBERG, designing engineer in the construction engineering department of the General Electric Company, Schenectady, N. Y., died June 13 following an attack of appendicitis. Graduated from Norrkoping College, Sweden, in 1900, with the degree of M.E., Mr. Sohlberg went to England in 1902 with the British Thomson Houston Company. In 1905 he entered the employ of the General Electric Company in this country, and in 1912 became designing engineer in the construction engineering department, specializing in the design and equipment of power plants and substations.

Personals

WALTER J. WOHLENBERG, professor of mechanical engineering at Yale University and authority on heat transfer and radiation, has just been appointed the first Sterling professor of engineering, a research professorship recently established at the university by a bequest of the late John W. Sterling. Internationally known for his research work on boiler design and radiation, Professor Wohlenberg is chairman of the A.S.M.E. Special Research Committee on Radiation, and is also a member of the National Research Council's committees on heat transfer and radiation. In the past he has acted as consultant on many important engineering enterprises and has been a member of several committees on fuel and power.

HARRY E. CLIFFORD, the Gordon McKay professor of electrical engineer at Harvard since 1909, has been chosen dean of the Harvard Engineering School, to succeed Hector J. Hughes, who died March 1. He will take office immediately upon his return from abroad. Professor Clifford is a fellow of the American Institute of Electrical Engineers and a member of the American Association for the Advancement of Science, and the American Academy of Arts.

RUDOLPH E. HELLMUND, chief electrical engineer for the Westinghouse Electric & Manufacturing Company, received the distinguished honor of the B. G. Lamme Award for 1929 as the American Institute of Electrical Engineers convened recently at Toronto. The medal, regarded as one of the outstanding tributes paid in electrical engineering, was awarded to Mr. Hellmund for his work on the design of induction motors. Mr. Hellmund is the second to receive the honor.

M. M. UMBARGER was elected president of the Sioux City (Iowa) chapter of the National Association of Power Engineers at the annual meeting last week, succeeding R. R. ROBINSON. C. E. LOLLEMON was named vice-president; R. A. HEILMAN, recording secretary; N. J. WATSON, financial secretary; C. H. AMOS, corresponding secretary, and J. A. COLSON, treasurer. Mr. Robinson and O. N. CUTRIGHT were named delegates to the national convention in Cleveland, Sept. 8 to 13.

P. F. CASSIDY, formerly chief lubrication engineer of the Tidewater Oil Company, has been appointed Eastern sales manager of the Garratt-Callahan Company.

SAM PITTS WOOLDRIDGE, local manager of the Alabama Power Company at Newton, Ala., has been awarded the Insull Medal for saving the life by artificial respiration of J. J. Dominey, a retired farmer of that city, after the latter had suffered a 2,300-volt shock from a broken transmission line.

Business Notes

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, East Pittsburgh, Pa., announces that through its subsidiary, the Westinghouse Electric International Company, it has entered into a comprehensive arrangement with the English Electric Company, Ltd., of London, whereby there will be an exchange of technical information between the two organizations on steam turbines and electrical apparatus. The arrangement grants licenses for the use of patents and for the manufacture and sale of various products. At the same time there comes an announcement that three new executive positions, the offices of commercial vice president, have been created by the board of directors of the Westinghouse company. C. E. Stephens has been selected to occupy the new position for the Atlantic division; N. G. Symonds for the Central division, and W. R. Marshall for the Pacific division.

PREST-O-LITE COMPANY, New York City, announces the opening of a new plant for the manufacture of dissolved acetylene at 1240 Stewart Ave., Atlanta, Ga. The old plant at 345 Kuhrt Street will discontinue operations.

BLAW-KNOX INTERNATIONAL CORPORATION is the new name for the export organization of the Blaw-Knox Company, Pittsburgh, Pa., which was formerly Milliken Brothers. This change in name is due to the larger scope of the company's activities and thoroughly identifies the export company as such. It embraces no change in personnel and the offices will remain as formerly, in the Canadian-Pacific Building, New York City.

BROWN INSTRUMENT COMPANY, Philadelphia, Pa., has just let a contract for the addition of 40,000 sq.ft. of floor space to its manufacturing facilities.

EDGE MOOR IRON COMPANY, Edge Moor, Del., announces the appointment of Harry L. Moody as general sales manager. Mr. Moody was formerly sales manager of the U. G. I. Contracting Company.

AMERICAN ARCH COMPANY, New York City, announces the removal of its main offices from 17 East 42d St. to 60 East 42d St., New York City.

WELDING ENGINEERING & RESEARCH CORPORATION, New York City, recently formed to provide a consulting service on engineering research and cost accounting problems in the welding field, announces the appointment of George Watson as general sales manager. Mr. Watson was formerly sales manager of the Wickwire Spencer Steel Company. His temporary address is 30 Church St., New York City, but as soon as the new laboratories are completed in Long Island City, N. Y., he will take quarters there.

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COMING CONVENTIONS

American Society of Mechanical Engineers. Annual meeting in New York City, Dec. 1-5. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. Annual Pacific Coast convention at Portland, Ore., Sept. 2-5. District meeting at Philadelphia, Pa., Oct. 13-15. District meeting at Louisville, Ky., Nov. 19-22. Secretary, F. L. Hutchinson, 33 West 39th St., New York City.

National Association of Power Engineers. Annual convention and exhibition of power machinery at the Cleveland Auditorium, Cleveland, Ohio, Sept. 8-13. Secretary, Fred W. Raven, 417 South Dearborn St., Chicago, Ill.

National Association of Practical Refrigerating Engineers. Annual convention and exhibition at the Hotel Peabody, Memphis, Tenn., Nov. 11-14. Secretary, Edward H. Fox, 5707 West Lake St., Chicago, Ill.

National Exposition of Power and Mechanical Engineering. Grand Central Palace, New York City, Dec. 1-6. Manager, Charles F. Roth, Grand Central Palace, New York City.

Universal Craftsmen Council of Engineers. Annual convention at the Hotel Kimball, Springfield, Mass., Aug. 5-8. Secretary, T. H. Jones, 33 Linden Ave., Cherrydale, Va.

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Trade Catalogs

STOKERS — Detroit multiple-retort stokers are illustrated and described in a new 32-page catalog just issued by the Detroit Stoker Company, General Motors Building, Detroit, Mich. Some of the features covered are the principle of the level fuel bed, the distribution of the fuel in each retort, the graduated distribution of air, the use of side-wall, wind boxes and the power-operated dump for large stokers.

ELEVATOR ROPE EQUALIZERS — The Evans Elevator Cable Equalizer Company, Chanin Building, New York City, has just issued a new catalog on its elevator rope equalizers, designed to overcome the difficulties caused by unequal stretch of the ropes and the differential travel due to uneven wear of the sheave grooves.

BOILERS—A complete description of longitudinal-drum, water-tube boilers, including details of construction, installation, etc., are contained in a new catalog published by the Union Iron Works, Erie, Pa.

CONTROLLERS—Under the title "Metered Combustion Control for Boiler Furnaces," Bulletin No. 660 of the Leeds & Northrup Company, 4901 Stenton Ave., Philadelphia, Pa., covers the control of stoker-fired and pulverized-fuel furnaces. It also contains a reproduction of an L. & N. CO_2 chart taken from a boiler equipped with Leeds & Northrup automatic combustion control.

ELECTRICAL EQUIPMENT — The Square D Company of Detroit, Mich., has just published three catalogs: No. 35-P featuring fuse cabinets, lighting panelboards and power panels; No. 35-S covering safety switches and square-duct; and No. 35 1-C on the industrial controller division.

CIRCUIT BREAKERS—A new line of high-voltage oil circuit breakers, Type GO, is announced by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., in two 8-page illustrated folders recently circulated.

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Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	At Mine, for Shipment to	Price per Ton
Navy Standard	New York	$2.25 @ $2.50
Kanawha	Cincinnati	1.15 @ 1.35
Smokeless	Cincinnati	1.85 @ 2.00
Smokeless	Chicago	1.75 @ 2.00
West Kentucky	Chicago	.85 @ 1.30
Steam	Pittsburgh	1.40 @ 1.65
Gas Slack	Pittsburgh	1.10 @ 1.25
Big Seam	Birmingham	1.60 @ 1.75

Anthracite (Gross Tons)	At Mine, for Shipment to	Price per Ton
Buckwheat	New York	$2.90 @ $3.00
Barley	New York	1.15 @ 1.50

FUEL OIL

New York—July 2, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75@5.25c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6@6.25c. per gal.

St. Louis—June 25, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.420 per bbl., or 42 gal.; 26@28 deg., $1.495 per bbl.; 28@30 deg., $1.570 per bbl.; 30@32 deg. $1.625 per bbl.; 32@36 deg., gas oil, 4.151c. per gal.; 38@40 deg., distillate, 4.98c. per gal.

Pittsburgh—June 18, f.o.b. local refinery, 30@34 deg., fuel oil, 3.5c.@3.75c. per gal.; 36@40 deg., 3.5c.@4.25c.

Philadelphia — June 30, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 18 deg. plus, $1.475@$1.525 per bbl.; 23@27 deg., $2.00@$2.05 per bbl.

Cincinnati — June 24, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

Chicago—June 14, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 75@80c. per bbl.; 26@30 deg., 85@90c. per bbl.; 30@32 deg., $0.95@$1.00 per bbl.

Boston—June 28, tank-car lots, f.o.b., 12@14 deg., Baumé, 3.33c. per gal.; 28@32 deg., 5c. per gal.

Dallas—June 28, f.o.b. local refinery 26@30 deg., $1.25 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ariz., Phoenix — Good Samaritan Hospital, awarded contract for a 4 story addition to hospital, to W. Peper, Phoenix. $250,000. Bids for boiler house, laundry, stack, etc., will be called for later.

Ariz., Randolph — Randolph Irrigation District, is having preliminary plans prepared for sinking 34 wells and equipping them with electrical pumps, also concrete lined canal to irrigate 9,500 acres of land. Estimated cost $400,000. D. Scott, Phoenix, is engineer.

Calif., Los Angeles—Chatsworth Water District, plans an election to vote $65,000 bonds for the construction of a waterworks system including reservoirs, pumping plant, mains, etc.

Conn., Newtown — Fairfield State Hospital Commission, State Capitol, Hartford, will receive bids until July 22 for the construction of a group of buildings for asylum to include garage, fire station, carpenter and paint shops, laundry power house, coal bunker, etc. at Mile Hill, here. Estimated cost $1,750,000. W. P. Crabtree, 410 Asylum St., Hartford, is architect.

Ill., Chicago — Treasury Department, Office of the Supervising Architect, Washington, D. C., will receive bids until July 17 for repairs to heating plant consisting of five Hawley down draft furnaces in high pressure steam boilers at Post Office here.

Ind., Hammond—Graham, Anderson, Probst & White, 80 East Jackson Blvd., Chicago, Ill., Archts., will receive bids until July 16 for the construction of a 194 x 380 ft. addition to electric generating station including boiler room, turbine room, paint and carpenter shops, etc. for State Line Generating Co., Hammond.

Ind., Marion—Indiana General Service Co., awarded contract for the construction of a 60 x 160 ft. substation, storage plant, etc. at Walnut and Branson Sts. to G. W. Heinzmann, 1740 West First St. Estimated cost $60,000.

Ia., Nevada—Iowa Railway & Power Corp., Cedar Rapids, Ia., will soon receive bids for the construction of a power plant. Estimated cost $200,000.

Kan., Ford—City plans the construction of waterworks and distribution systems including pumps, mains, tank on tower, etc. Estimated cost $30,000. Shockley Engineering Co., 800 Graphic Arts Bldg., Kansas City, Mo., is engineer.

Ky., Aurora—Southern Industries & Utilities Inc., Washington, D. C., is having tentative plans made for the construction of a dam, 6,000 ft. long and 50 ft. high on the Tennessee River here. The lakes so formed covers 132,000 acres. Total estimated cost $32,000,000. W. G. Waldo, Washington, is chief engineer. Francis R. Weller Inc., Mills Bldg., Washington, are associate engineers.

Md., College Park—University of Maryland, is having plans prepared for the construction of a central heating plant. Estimated cost $200,000. Smith & May, Calvert Bldg., are architects. H. Massart, 324 North Charles St., is engineer.

Mass., Lawrence—Meadow Brook Laundry Co., 17 North Methuen St., is having revised plans prepared for the construction of a power house. Estimated cost including equipment $40,000. H. Petzold, Bay State Bldg., is engineer. Former bids rejected.

Mass., Lynn—City, D. Dinneen, City Hall, will receive bids until July 22 for the construction of a police station garage, boiler house and heating plant. Estimated cost $150,000. Private plans.

Mich., Northville—W. H. Maybury Sanitorium, awarded contract for addition to sanitorium including power house, etc. to W. E. Wood Co., Union Trust Bldg., Detroit. $388,500.

Mich., Traverse City—Michigan Public Service Co., awarded contract for the construction of an earth dam, 475 ft. long and 45 ft. high on Boardman River including power house to develop 2,200 kw. to Price Bros. Co., Lansing. Estimated cost $500,000. Generating equipment has been purchased.

Miss., Hattiesburg—Bd. of Water Comrs., will receive bids until July 24 for the installation of a new water plant on the banks of the Bourie River including filter plant, pumping plant, etc. Estimated cost $500,000.

N. J., Secaucus—Bd. of Chosen Freeholders, Court House, Jersey City, received lowest bid for the construction of a power house, boiler room and smoke stack at New Contagious Diseases Hospital here from DeReso Construction Co., 921 Bergen Ave., Jersey City. $40,944.

N. Y., Batavia—City plans an election July 22 to vote either $300,000 for gravity system or $100,000 under Fox plan to electrify and repair present pumping station in connection with waterworks.

O., Akron—Bd. of Education, received lowest bid for the construction of a 3 story, 70 x 282 ft. high school including boiler room on Copley Rd. from Higley Construction Co., 714 North Main St. $291,500.

Oklahoma — Grand Hydro Co., Tulsa is having plans prepared and will receive bids in about sixty days for the construction of a hydro-electric dam on Grand River northeast of here. Estimated cost $500,000. Fargo Engineering Co., Jackson, Mich., are consulting engineers.

Texas—Missouri-Kansas Pipe Line Co., 820 Dwight St., Kansas City, Mo., awarded contract for equipment including engine compressor equipment and 20,000 hp. compressor for proposed natural gas pipe line from Texas Panhandle to points in Missouri to Cooper-Bessmer Corp., 200 Thomas Ave., Mt. Vernon, O. $1,000,000.

Texas—Phillips Petroleum Co., Bartlesville, Okla., plans the construction of ten pumping stations equipped with electric motor driven centrifugal pumps or Diesel type engines in connection with proposed 800 mi. pipe line between Borger, Tex. and St. Louis, Mo. Estimated cost $800,000. Private plans. Manufacturers or dealers communicate with owners direct.

Tex., Carlsbad — State Tuberculosis Sanitorium, plans improvements to physical properties of sanitorium including ice plant, addition to laundry plant, etc. Estimated total cost $50,000. Private plans.

Tex., Del Rio—Central Power & Light Co., Frost Bldg., San Antonio, is having preliminary surveys made for the construction of an ice plant at Devils River Highway near here. Estimated cost $60,000. Private plans.

Tex., Denton—City, W. N. Harris, Engr., will receive alternate bids for the construction of a 50 and 25 ton ice plant.

Va., Richmond—St. Joseph's Orphanage, awarded contract for the construction of a central heating plant at Hollybrook in connection with group of buildings to C. Boehling Co. Total estimated cost $1,000,000. Other contracts to be let soon.

Wash., Tacoma—City received lowest bid for construction complete with appurtenances of the structural steel frame for municipal power plant No. 2 on Hylebos waterway from O. F. Larson, Tacoma, $41,822.

Wash., Seattle—Two City ordinances to appropriate $414,000 for a new steam-driven power plant for City Light Department near Spokane Street bridge have been vetoed by the Mayor and upheld by City Council. As a substitute for these plans, the Council is preparing a measure which would enlarge the present steam plant on Lake Union. This will provide for installation of one new generating unit.

Ont., London—Huron & Erie Mortgage Corp., awarded contract for a 9 story office building on Dundas St. to Piggott Construction Co., 36 James St. S., Hamilton. Steam heating system, etc. will be installed.

Ont., London—Canadian Mineral Baths, 420 Talbot St., will soon receive bids for the construction of a health bath house including electric pumps, two 110 hp. steam boilers, storage tanks, etc. D. Bright, 119 King St., is engineer.

New Zealand—Government is endeavoring to secure the services of an outstanding Canadian engineer to effect repairs to the recently completed Arapunia power plant.

Equipment Wanted

Pumps, etc.—Mission, Tex.—Hidalgo County I. Dingeman, County Drain Comr., will receive bids until July 22 for a motor driven centrifugal pump and equipment for proposed sewage treatment plant.

Pumps, etc.—Mission, Tex.—Hidalgo County Water Contral & Improvement Dist. 11, pumps, etc. in connection with proposed irrigation work. Estimated cost $90,000.

Industrial Projects

Ind., Marion—Silent Alarm Co., will build a factory on East Charles St. Estimated cost $41,000. Private plans. Work will be done by owners forces.

Kan., Kansas City—Colgate Palmolive Peet Co., 919 North Michigan Ave., Chicago, Ill., awarded contract for the construction of a 25 x 25 ft. factory here to Kansas City Structural Steel Co., 21st St. and Metropolitan Ave., Kansas City, Mo. Estimated cost $100,000.

Mass., Dorchester (Br. Boston)—Albree Marble & Tile Co. Inc., 9 Ashland St., awarded contract for the construction of a 1 story, 100 x 100 ft. factory at Mt. Vernon St. and Columbia Rd. to I. H. Bogart Co., 60 State St., Boston. Estimated cost $50,000.

Mich., Muskegon — Brunswick Radio Corp., Laketon St., subsidiary of Warner Bros., (Pictures) plans the construction of a 1 story, 280 x 400 ft. factory. Estimated cost $300,000. Private plans.

Minn., Cloquet — Northwest Paper Co., awarded general contract for the construction of a 1 story, 125 x 724 ft. addition to plant to James Leck Co., 211 South 11th St., Minneapolis; paper machine to Beloit Iron Works, Beloit, Wis., and general engineering to Jacob Engineering Co., 430 Oak Grove, Minneapolis. Estimated total cost $350,000.

Neb., Omaha—Quaker Petroleum Co., 14th and Nicholas Sts., will receive bids about Aug. 1 for the construction of a 56 x 210 and 60 x 96 ft. oil compounding and barreling plant at 20th and Hickory Sts. J. G. McArthur, 307 Keeline Bldg., is architect.

N. J., Belleville — Fletcher-Thompson Inc., 542 Fairfield Ave., Bridgeport, Conn., Archts., will receive bids until July 8 for a 4 story, 78 x 170 ft. addition to factory for the manufacture of chlorine apparatus at Schuyler Ave. and Terrace Pl., for Wallace & Tierman Products Co., Inc., 11 Mill St., Belleville. Estimated cost $150,000.

N. J., Harrison—Driver-Harris Co., Middlesex St., will receive bids about Aug. 1 for a 1 and 2 story addition to factory for the manufacture of alloys for electrical resistance and castings for annealing, carbonizing, hardening and tempering. Estimated cost $250,000. J. A. Finegan, 776 Broad St., Newark, is architect.

N. J., Trenton—Trenton Potteries Co., North Clinton Ave., awarded contract for a 1 story addition to pottery plant at North Clinton Ave. between Ott St. and Dewey Ave. to Karno-Smith Co. Inc., Broad St. Bank Bldg. Estimated cost $40,000.

N. Y., Brooklyn—Federal Plumbing Supply Co., 1721 St. Marks Ave., is having sketches made for a 3 story, 46 x 117 ft. factory and storage building at St. Marks and East New York Aves. Estimated cost $40,000. E. M. Adelsohn, 26 Court St., is architect.

N. Y., Buffalo—J. H. Williams & Co., 400 Vulcan St., manufacturers of drop forge products and machine tools, are receiving bids for the construction of a 1 story factory. Estimated cost $50,000.

O., Cleveland—Cleveland Trencher Co., A. V. Jones, Gen. Mgr., 20100 St. Clair Ave., is having plans prepared for a 1 story, 60 x 90 ft. addition to factory. Estimated cost $40,000. P. Schmidt, 4500 Euclid Ave., is architect.

O., Toledo—Toledo Union Produce Terminal Inc., is having negotiations made for the construction of a produce terminal including refrigeration plants, storage and shipping facilities, etc. Estimated cost $1,500,000.

Pa., Philadelphia—Becker-Smith & Page, Water and Snyder Sts., manufacturers of wall paper, will soon award contract for the construction of a 2 and 3 story, 117 x 305 ft. factory. Ballinger Co., 12th and Chestnut Sts., is architect.

Wash., Seattle—Ford Motor Co., Dearborn, Mich., plans the construction of and equipment for 100 x 300 ft. plant to include 100 x 500 ft. warehouse, power and oil houses, etc., here. Estimated cost $3,000,000. A. Kahn, Inc., 1000 Marquette Bldg., Detroit, Mich., is architect.

Que., East Montreal—Canadian Copper Refiners, subsidiary of Nichols Copper Co., Washington St., Long Island City, N. Y., awarded contract for excavation for copper refinery to Kendall Bros., 1853 Iberville St., Montreal, and steel to Canadian Vickers Ltd., Maisonveuve, Que. Estimated cost $2,000,000.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

PRICES declined during the last two weeks of June in rubber-covered copper wire, flexible cord and armored cable. The marked upward tendency now observed in conduit, elbows and couplings may soon result in higher quotations. Some buying at prices mentioned in the accompanying table will continue for a few days at least, in cases where jobbers still have stock purchased at the old prices. It is thought, however, that the increase will not exceed 5 per cent. Metals and construction materials, except paint, continue on the downward course, with no visible indication of any sudden reversal of trend.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

	Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket		(net)*60c. per ft.
Common, 2½-in., cotton, rubber-lined, 80c. per ft., list, less		50%

Air—Best grade

¾-in., per ft.	3-ply....$0.30	4 ply....$0.36

Steam—Discounts from List

First grade....40%	Second grade.....45%	Third grade....50-10%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. The following discounts from New York warehouse list apply to rubber transmission belting in quantities of about ½ doz. rolls:

Best grade	50%
Second grade	60%

LEATHER BELTING—List price, 24c. per lin.ft., per inch of width, for single ply, at New York warehouses in quantities of about ½ doz. rolls:

Grade	Discount from list
Medium	30-10%
Heavy	30%

RAWHIDE LACING—For cut, best grade, 30-5%; 2nd grade, 45-5%. For laces in sides, best, 57c. per sq.ft.; 2nd, 52c., net. Semi-tanned, cut, 30-5%.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ⅛ in.	$0.90
Asbestos for high-pressure steam, ⅛ in.	1.75
Duck and rubber for piston packing	.90
Flax, regular	1.15
Flax, waterproofed	1.70
Compressed asbestos sheet	.85
Wire insertion asbestos sheet	1.20
Rubber sheet	.45
Rubber sheet, wire insertion	.75
Rubber sheet, duck insertion	.55
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts from list at New York warehouses are as follows:

85% magnesia, high pressure		40 %
Asbestos, air cell, for low-pressure heating and return lines	4-ply	65 %
	3-ply	67½%
	2-ply	70 %

PORTLAND CEMENT—New York, $2.10 per bbl., without bags, delivered by truck to site of job. Bag charge, 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, beams and channels, 3 to 15-in.; angles, 3 to 6-in., ¼-in. thick; tees, 3-in. and larger; and plates, ¼-in. thick and heavier; all $3.30 per 100 lb. in lots up to 3,999 lb.

COTTON WASTE—The following prices are in cents per lb., at warehouse:

	New York	Cleveland	Chicago
White	13.00	16.00	15.00
Colored	9.50	12.00	12.00

WIPING CLOTHS—Prices per pound in lots of about 600 lb., for washed white wipers, as follows:

Chicago (100 lb. bales)	$0.16
New York (100 lb. bales)	.13½
Cleveland (per thousand)	38.00

LINSEED OIL—These prices are for raw oil in barrels, f.o.b., in 1 to 4 bbl. lots:

	New York	Cleveland	Chicago
Per pound	$0.148	$0.164	$0.152

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b., New York:

	Dry	In Oil
Red	$13.75	$15.25
White	13.75	14.25

RIVETS—The following quotations apply on fair-sized orders from warehouse:

Tank rivets, ⅞-in. diameter and smaller, list (Apr. 1, 1927) less 60% in full packages, for immediate delivery from warehouse stocks in New York and vicinity.

Structural rivets, ½-in., round head, per 100 lb.:

New York	$4.50*
Chicago	4.00
Pittsburgh mill	2.90

*This price is for full kegs; broken-kegs are $6.00 per 100 lb.

REFRACTORIES—Prices in car-loads, f.o.b. plant:

Chrome brick, eastern shipping points	per net ton	$45.00
Chrome ore, ground, 40@50%, Cr_2O_3, in bulk	per net ton	22@25
Chrome ore, ground, 40@50%, Cr_2O_3, in sacks	per net ton	26@29
Chrome ore, crude, 40@50%, Cr_2O_3	per net ton	18.00@22.50
Magnesite brick, 9-in. straights	per net ton	65.00
Magnesite brick, 9-in. arches, wedges and keys	per net ton	71.50
Magnesite brick, soaps and splits	per net ton	91.00
Silica brick, Mt. Union, Pa	per M	43.00
Clay brick, 1st quality, 9-in. shapes, Pennsylvania	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Maryland	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Colorado	per M	40@43
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Maryland	per M	35@38

BABBITT METAL—Delivered in case lots from New York warehouse, on orders of 100 lb. or over, cents per pound:

Genuine, highest grade	50.00
Commercial genuine, intermediate grade	[illegible]00
Anti-friction metal, general service	31.00
No. 4 babbitt, f. o. b.	11.00

COLD-FINISHED STEEL—Shafting and screw stock, warehouse prices per 100 lb., base, are as follows:

	New York	Cleveland	Chicago
Round or hexagon	$3.40	$3.65	$3.35
Flat or square	3.90	4.15	3.85

BOILER FITTINGS—F.o.b. warehouse, Jersey City, N. J., discounts from list:

Copper ferrules	70%
Boiler flanges	65-5%
Boiler stay bolts	60%
Boiler patch bolts	20%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%

WROUGHT PIPE—The following basing discounts from list are for large mill lots at Pittsburgh mill:

BUTT WELD

	Steel			Iron	
Inches	Black	Galv.	Inches	Black	Galv.
1 to 3	64%	52½%	¼ and ⅜	31%	15%

LAP WELD

2	57%	45½%	2	23%	9%
2½ to 6	61%	49½%	2½ to 3½	28%	13%
7 and 8	58%	45½%	4 to 6	30%	17%
9 and 10	56%	43½%	7 and 8	29%	16%
11 and 12	55%	42½%	9 to 12	26%	11%

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	62%	51½%	¼ to 2	34%	18%
2 to 3	63%	52½%			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	55%	44½%	2	29%	13%
2½ to 4	59%	48½%	2½ to 4	34%	20%
4½ to 6	58%	47½%	4½ to 6	33%	19%
7 and 8	54%	41½%	7 and 8	31%	17%
9 and 10	47%	34½%	9 to 12	21%	8%
11 and 12	46%	33½%			

BOILER TUBES—Standard gage, manufactured in accordance with the specifications and requirements of the American Society of Mechanical Engineers and in compliance with the rules and regulations of the U. S. Steamboat Inspection Service, from New York warehouse stock, per 100 ft.:

Size, Inches*	B.W.G.	Toncan Seamless Iron	Knobbled Charcoal Iron	Seamless Steel	Lapwelded Steel
1	13	$34.00	.....	$18.00	.....
1¼	13	37.75	.....	20.25	.....
1½	13	38.00	$38.00	19.25	.....
1¾	13	30.00	30.00	22.00	.....
2	13	26.25	26.25	20.25	$19.00
2¼	13	34.50	34.50	23.00	25.00
2½	12	34.00	34.00	26.00	24.25
2¾	12	40.50	40.50	28.50	27.50
3	12	42.50	42.50	27.00	25.50
3¼	11	50.25	50.25	30.75	28.75
3½	11	54.50	54.50	33.25	31.50
4	10	67.00	67.00	40.00	38.00

These prices are based on stock lengths. If cut to special lengths billing will be based on the entire stock lengths. In addition to the foregoing, standard cutting charges are as follows:

2-in. and smaller.. $0.05 per cut
2¼ and 2½ in..... .06 per cut
3-in..... $0.09 per cut
3¼ to 4 in.. .10 per cut

*External diameter.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft., New-Style, A.B.C., with fibre bushing:

B. & S. Size	BX Two Cond. M. Ft.	BX Three Cond. M. Ft.	Lead Two Cond. M. Ft.	Lead Three Cond. M. Ft.
No. 14 solid....	$26.00	$42.00	$115.00	$143.00
No. 12 solid....	41.00	41.75	117.00	166.00
No. 10 solid....	57.00	72.00	137.00	189.00
No. 8 stranded..	91.00	115.00	220.00	295.00
No. 6 stranded..	135.00	163.00	295.00	.....

Coils to 1000 ft., +10%; less than coil lots, +20%.

CONDUIT—Rigid iron, price per 1,000 ft.; **ELBOWS AND COUPLINGS,** per 100 pieces, extra. New York warehouse shipment. Discount of 5 per cent for payment in 10 days; 30 days net.

Size, Inches	GALVANIZED Conduit	GALVANIZED Elbows	GALVANIZED Couplings	BLACK Conduit	BLACK Elbows	BLACK Couplings
¾	$58.30	$8.33	$4.79	$53.27	$7.21	$4.38
¾	74.34	10.97	6.84	67.55	9.49	6.25
1	106.55	16.24	8.90	96.50	14.04	8.14
1¼	144.16	21.97	12.48	130.57	19.31	11.47
1½	172.37	29.31	15.41	156.11	25.76	14.17
2	231.91	54.71	20.55	210.04	47.20	18.90
2½	366.67	87.91	29.36	332.10	77.27	27.01
3	479.50	234.10	44.04	434.29	205.74	40.50
3½	603.84	516.92	58.74	549.47	454.09	54.02
4	736.89	597.18	73.41	672.47	524.78	67.50
4½	858.58	904.12	110.00	783.52	794.50	101.23
5	1000.55	1255.26	121.13	913.08	1103.08	111.37
6	1298.01	1560.33	176.12	1184.54	1371.20	161.93

CONDUIT BODIES AND FITTINGS—Black or galvanized:

	Less Than $15 List	$15 List to $100	$100 List and Over
Standard package	15%	20%	28%
Less than standard package	10%	15%	20%

CUT-OUTS—Following are net prices, each, in standard-package quantities:

CUT-OUTS, PLUG, SOLID, NEUTRAL OR 2-FUSE

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE, SOLID, NEUTRAL OR 2-FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy		$15.00
No. 16 cotton reinforced heavy		19.00
No. 18 cotton reinforced light		12.00
No. 16 cotton reinforced light		14.00
No. 18 cotton Canvasite cord		13.00
No. 16 cotton Canvasite cord		15.00
No. 16 super service cord or similar (2 wire) in 1,000 ft.	$64.00	*71.00
No. 14 super service cord or similar (2 wire) in 1,000 ft.	92.00	*101.00

*Less than 1,000 ft.

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List Each
3-amp. to 30-amp.,	100	$0.15	3-amp. to 30-amp.,	100	$0.30
35-amp. to 60-amp.,	100	.30	35-amp. to 60-amp.,	100	.60
61-amp. to 100-amp.,	50	.90	65-amp. to 100-amp.,	50	1.50
101-amp. to 200-amp.,	25	2.00	110-amp. to 200-amp.,	25	2.50
201-amp. to 400-amp.,	25	3.60	225-amp. to 400-amp.,	25	5.50
401-amp. to 600-amp.,	10	5.50	450-amp. to 600-amp.,	10	8.00

Discount: Less than one-fifth standard package, 60%; one-fifth to standard package, 65%; standard package, 68%.

RENEWABLE FUSES—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.....	$0.50	$1.10	100	10
35 to 60-amp.....	1.00	1.25	100	10
65 to 100-amp.....	2.00	3.00	50	5
110 to 200-amp.....	4.00	5.00	25	5
225 to 400-amp.....	7.50	11.00	25	1
450 to 600-amp.....	11.00	16.00	10	1

REFILLS—

1 to 30-amp.....	$0.03 ea.	$0.05	100	100
35 to 60-amp.....	.05 ea.	.06	100	100
65 to 100-amp.....	.10 ea.	.10	50	50
110 to 200-amp.....	.15 ea.	.15	25	50
225 to 400-amp.....	.30 ea.	.30	25	25
450 to 600-amp.....	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken cartons	Net list
Unbroken cartons	17%
Ten unbroken cartons	34%
Discount Without Contract—Renewals:	
Broken cartons	Net list
Unbroken cartons	17%
Ten unbroken cartons	34%
Discount With Contract—Fuses:	
Broken cartons	5%
Unbroken cartons	20%
Ten unbroken cartons	36%
Discount With Contract—Renewals:	
Broken cartons	Net list
Ten unbroken cartons	36%

Carton quantities may be combined to obtain maximum discounts.

FUSE PLUGS, MICA CAP—

0–30 ampere, standard package (500), per 100	$2.80
0–30 ampere, less than standard package, per 100	3.10

LAMPS—Below are present quotations in less than standard package quantities on Mazda standard, A type bulbs:

100—130 Volt— Watts	General Type	Price Each	200—260 Volt— Watts	Special Type	Price Each
15	A 17	$0.20	25	A 19	$0.25
25	A 19	.20	50	A 21	.25
40	A 21	.20	100	A 23	.45
50	A 21	.20	...	.....	.....
60	A 21	.20	...	.....	.....
100	A 23	.35	...	.....	.....

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75 to $300,000 net, allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain, separable, attachment plug	$0.18
Composition, 2-piece, attachment plug	.27
Swivel attachment plug	.12
Small size, 2-piece plug, composition	.07

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f.o.b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Solid Duplex
14	$5.40	$7.20	$7.80	$14.00
12	7.50	9.05	10.10	17.60
10	10.20	11.90	13.10	23.60
8	14.80	17.40	19.00	34.80
6	.....	.....	26.50	.....
4	.....	.....	39.00	.....
2	.....	.....	55.40	.....
1	.....	.....	91.00	.....
0	.....	.....	98.00	.....
00	.....	.....	117.00	.....
000	.....	.....	140.00	.....
0000	.....	.....	171.00	.....

SOCKETS, BRASS SHELL—Price each, net:

	½ In. or Pendant Cap— Key	Keyless	Pull	¾ In. Cap— Key	Keyless	Pull
Standard package	$0.12	$0.10	$0.16	$0.16½	$0.14	$0.20
Unbroken carton	.14	.12	.18	.18	.16	.21
Broken carton	.16	.14	.20	.20	.18	.24

WIRING SUPPLIES—

Friction tape, ¾ in., in less than 100 lb., 30c. per lb.; in 100 lb. lots, 28c. per lb.
Rubber tape, ¾ in., in less than 100 lb., 32c. per lb.; in 100 lb. lots, 29c. per lb.
Wire solder, in less than 100 lb., 30c. per lb.; in 100 lb. lots, 28c. per lb.
Soldering paste, 2 oz. cans ..... $1.10 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c. or a.c., N.E.C.:

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$3.50	$5.70	$9.00
60	9.00	11.00	14.00
100	14.00	17.00	29.00
200	22.00	29.00	48.00

Discounts:	
Standard package	40%
Less than standard package	35%